NEW YORK INDUSTRIAL EXHIBITION.

SPECIAL REPORT

OF

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MR. WHITWORTH'S

SPECIAL REPORT.

HAVING been unavoidably prevented, as explained in the General Report of the Commission, from making a report upon the Machinery exhibited in the New York Industrial Exhibition, I have drawn up in a concise form the results of observations made while visiting the principal seats of those manufactures which came within my department.

The statement thus prepared embraces a variety of subjects, somewhat miscellaneous in their character, and which do not conveniently admit of a regular classification. I have endeavoured, however, as far as possible to overcome this difficulty, and to adopt an arrangement by which the substance of the information which I collected may be distinctly and fully appreciated. This Report does not affect to embrace the whole scope of American manufactures, nor even to exhaust the interest of those particular departments upon which it touches; it is merely intended to direct attention to such facts connected with the Machinery of the United States as came within my observation, and which it appeared desirable should be known to those engaged in mechanical and industrial pursuits in this country.

To the general reader many of the descriptions of manufacturing processes will, I am aware, be uninteresting, and in some cases perhaps unintelligible; for, looking to the persons for whose information I have more immediately written I have thought it proper to adhere to those technical terms which are in use among men who are more or less acquainted with the application of mechanical science. For instance, when in describing a cotton mill in America I have said, "One man can attend to a mule containing 1,088 spindles, each spinning 3 hanks, or 3,264 hanks on the average per day," I am aware that I am using technical language incomprehensible to the ordinary reader, but these few words convey all the requisite information to those practically acquainted with the subject. I have not, therefore, attempted to impart a popular tone to the Report; and the very few general reflections which I have ventured to offer, are given at its close.

Some works have been noticed for their novelty and interest, others for their practical utility as affecting our native industry, and in some instances the information which I have collected has been directed to convey a general idea of the extent to which particular branches of manufactures are developed, of the conditions, as to management, under which they are carried on, and of the causes to which their flourishing condition is chiefly due.

The accidental absence of principals at the period of my visits, the limited time at my disposal, and my anxiety to embrace as wide a field of observation as possible, have severally constituted impediments where more minute information might have seemed desirable; but whatever may be the defects of this necessarily imperfect Report, I desire to record my sincere acknowledgments for the great courtesy and the kind attention which I received on all hands during my visit to the United States; I am the more bound to do so as the plan which I have pursued has precluded me from mentioning the names of many gentlemen who so greatly facilitated the objects of my visit, by showing me over their own establishments, accompanying me to those of others, and affording me all the information in their power.

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CHAPTER I.

STEAM ENGINES AND MACHINERY.

New York, Philadelphia, Baltimore, Pittsburgh, Buffalo, Boston, Lowell, Lawrence, Holyoke, Worcester, Hartford, and Springfield.

1. *Number of Establishments visited.*—The vast resources of the United States are now being developed with a success that promises results whose importance it is impossible to estimate.

This development, instead of being, as in former cases, gradual and protracted through ages, is by the universal application of machinery effected with a rapidity that is altogether unprecedented.

Upwards of thirty establishments visited in different parts of the States, and employing in the aggregate from 6,000 to 7,000 men, afforded direct evidence that the greatest energy and attention are brought to bear upon the manufacture of machinery.

2. *Marine Engine Works.*—The principal marine steam engine works are in New York, but there are large establishments of a mixed character in almost every town of importance; to particularise these and to give a full description of each is unnecessary. They are similar in character, and it frequently happens that it is only in some of the details that there is anything to remark upon. The practice which prevails of combining various branches of manufacture in the same establishment, would also render separate descriptions of each somewhat complicated. For instance, in some cases the manufacture of locomotives is combined with that of mill gearing, engine tools, spinning and other machinery. In others, marine engines, hydraulic presses, forge hammers, and large cannon were all being made in the same establishments. The policy of thus mixing together the various branches is objec-

tionable, but the practice doubtless arises, in addition to other causes, from the fact that the demand is not always sufficient to occupy large works in a single manufacture.

Wherever facilities of carriage or other causes render it practicable to confine establishments to a special branch, the most advantageous results ensue. This was very evident in numerous and striking instances which will be hereafter noticed.

It is to the introduction of railroads that the advantageous subdivision of manufactures is to be chiefly ascribed. The operations of large establishments are no longer confined to particular localities: the facilities of transport being so great, they are enabled to supply their special products not only to a district or a kingdom, but to the world at large.

It is evident that isolated notices of details made in various places must have a disconnected character, and it is therefore convenient to mention in separate paragraphs what appeared worthy of remark.

3. *Locality of Works.—Beam Engines.*—Nearly all the marine engine works in New York are conveniently situated on the water side, and have slips attached to their yards, where vessels may be moored. The rise and fall of the tide is generally so small as to obviate the necessity of docks. Steam engines having their beams above the deck, are commonly used for the river and ferry boats, and they have generally a very long stroke. The following are some of the dimensions of a beam engine of one of the New York river steamers.

Length of stroke, 12 feet; length of beam, 24 feet; depth of beam in the middle, 10 feet. The form of the beam is that of an elongated parallelogram, the outer frame or skeleton is made in one piece of wrought iron, inside of which is fitted another frame of cast iron, carrying the axis.

4. *River Steamers for Shallow Waters.*—A steamboat running on the Ohio from Pitsburgh to Cincinnati, had a pair of direct acting engines with 32 inch cylinders and 8 feet stroke. There was no main crank shaft

connecting the two paddle wheels, but each engine worked its own wheel independently of the other. This arrangement enables the boat to be steered with greater facility round the sharp turns encountered in the tortuous course of the river. The framework and outer bearings of the paddle-wheels are supported by suspension rods, which are, as it were, slung over beams, and framework strongly constructed and fixed in the centre of the vessel. The main deck is 280 feet long, and 58 feet wide. The paddles are 38 feet in diameter, having twenty-four floats, 12 feet wide by 28 inches in depth. For shallow rivers, flat-bottomed steamers propelled by a paddle-wheel at the stern are commonly used. Two were being built of iron in New York, drawing only 2½ feet of water, which are intended for the passage across the isthmus of Panama by the Nicaragua route.

5. *Lake Steamers.—Propellers.*—A marine engine establishment at Buffalo was principally occupied in making engines for screw steamers intended for lake and river navigation. The propellers of those intended to run in shallow waters are made with four, and sometimes six blades, each, and revolve with rather less than half their diameter immersed in the water. The blades are made of wrought iron, and bolted on to a cast-iron boss, fitted on the propeller shaft, so that a blade broken or damaged by coming in contact with "snags," or other obstructions, may be easily replaced. Some of the dimensions of the machinery in a lake boat, used for carrying cargo, are as follows:—The propeller is 16 feet in diameter, with a pitch of 17 feet 3 inches, making 60 revolutions per minute; the cylinders are 36 inches in diameter, with a 10 feet stroke, and the speed attained averages about eleven miles per hour. The vessel has an upper deck for the accommodation of about sixty passengers. Small high-pressure steam engines for flour mills, agricultural implements, and other machinery, are made in the same establishment.

6. *Caloric Engines.*—Ericsson's caloric engines were undergoing repair and alteration in New York, with the view of making the heated air act alternately upon each side of the piston, similarly to steam in an

ordinary engine. The bottom of the cylinder is made of wrought iron, and arched. The upper part, in which the piston works, is of cast iron, and is connected to the lower part by bolts: it was this lower portion which proved defective in strength.

It was expected that the vessel, with her caloric engines, would be again ready for sea in the course of two or three months.

CHAPTER II.

PROCESS OF CASTING, COOLING, &C., RAILWAY WHEELS, AND ANNEALING—RAILROAD SPIKE MAKING—NAIL AND RIVET MAKING—CAST-STEEL WORKS—ENGINE TOOLS.

Pittsburgh, Philadelphia, Lawrence, Worcester.

7. *Iron Castings.*—The iron castings in some of the establishments were very good, and cylinders from 8 to 14 feet in diameter were well bored, with a finishing feed of cut of about three-eighths of an inch per revolution, which is at a width of cut at least three times as great as that ordinarily given in English works.

At Pittsburgh a large casting for a hydraulic press was cooled by the following method:—Water is introduced into the interior of the core by a pipe, which extends to the bottom, and fills it previous to casting. Provision is made for the escape of the air by making the core fluted.

When the metal is poured into the mould it immediately heats the water, which is then drawn off by an escape pipe at the top of the core, and a supply of cold water is continually running in at the bottom.

Heat is thus gradually taken from the mass, and the whole cools uniformly. The casting was 10 inches thick, and weighed 7 tons. It took from three to four days in cooling.

The best charcoal pig iron was selling in Pitsburgh at $45 per ton, having risen within a short period from $30 per ton.

Major Wade, of Pittsburgh, has made many experiments on the tensile strength of this iron. He found that it required a force of 45,000 pounds to tear asunder a bar an inch square. Some of the results of his experiments have been published by the United States Government in the "Ordnance Manual."

8. *Pickling Castings.*—The process of "pickling castings," as it is called, is performed in the following manner:—

The castings are placed on two wooden stages, covered with lead, each being 20 feet by 12 feet wide, and supported by two rollers, about 18 inches from the floor.

The trough containing the pickle (which consists of 2½ parts of water to 1 of acid) is of the same length as the stages, which are inclined towards it, to enable it to receive the drainings. The diluted acid is poured over the castings by hand from a long ladle, and when they are dry, the operation is repeated as often as necessary.

The stages are then inclined in the opposite direction, and cleansed from the coating of acid and sand by a powerful stream of water directed upon them from a hose pipe.

In England when the process of pickling is adopted for light castings, it is usual to immerse them in the liquid. The American method was probably adopted in consequence of the high price commanded by manual labour.

9. *Annealing Railway Wheels.*—The leading and trailing wheels of locomotives, and railway carriage-wheels, are commonly hollow cast-iron disc wheels.

The process of annealing adopted in a large manufactory in Philadelphia is as follows:—

The wheels are taken from the moulds, as soon after they are cast as they can bear moving without changing their form, and before they have become strained while cooling. In this state they are put into a circular furnace or chamber, which has been previously heated to a temperature about as high as that of the wheels when taken from the mould; as soon as they are deposited in this furnace or chamber, the opening through which they are passed is covered, and the temperature of the furnace and its contents is gradually raised to a point a little below that at which fusion commences. All the avenues to and from the interior of the furnace are then closed, and the whole mass is left to cool gradually as the heat permeates through the exterior wall, which is composed of fire-brick 4½ inches thick, inclosed in a circular case of sheet iron ⅛ inch thick.

By this process the wheel is raised to one temperature throughout before it begins to cool in the furnace, and, as the heat can only pass off through the medium of the wall, all parts of each wheel cool and contract simultaneously. The time required to cool a furnace full of wheels in this manner is about four days.

By this process wheels of any form, and of almost any proportions, can be made with a solid nave.

The manufacture of these wheels was commenced in 1847, and in 1850 15 tons weight were cast per day. The foundry and works as now completed are calculated to turn out 40 tons per day.

In another establishment the wheels while hot are lifted from the mould, and the centre part is placed in a hole communicating by means of a flue with a high chimney, and the edge is packed round with sand. A draft is thus created which cools the mass of iron near the centre of the wheel, and in some measure prevents it from contracting unequally during the operation.

At a foundry in Worcester, the wheels when cast were taken hot from the moulds, and immersed in a pit of white sand, where they are left to cool gradually.

In order to obtain the best chill, it is considered necessary to use cold blast iron made with charcoal.

10. *Railroad Spikes.*—There is a large demand for railroad spikes in the United States.

On nearly all the railroads the rails are laid on transverse wooden sleepers, and are simply fastened down by large iron spikes with projecting heads, except at the junction of two rails, where the ordinary chair is employed.

In a manufactory at Pittsburgh, a machine was at work which made these spikes, each weighing ½lb., at the rate of 50 per minute. They are packed in kegs, each containing 300. Seven men only are employed on the works, and they manufacture 5 tons of spikes per day.

11. *Nails and Rivets.*—In another establishment at Pittsburgh, 250 men are employed in manufacturing bar iron, rods, sheets, and nails. The iron is manufactured both with anthracite coal and charcoal.

They have 51 machines for making cut nails, many of them are self-acting in the feeding for the smaller sizes, the strip of iron is inserted in a tube, which is made to revolve alternately half round each way.

They make 2000 kegs of such nails per week, each weighing 100 lbs., and containing sizes from fourpenny up to tenpenny nails.

A rivet-making machine was at work which made rivets weighing 7 to the pound, at the rate of 80 per minute. Its main shaft carried two cams, one a side cam which gave the motion for cutting off and holding the iron between the dies, the other a direct cam for forming the head of the rivet.

The cams for the nail machines are made of chilled cast-iron, and that part of the lever which acts against the cam is faced with a plate of bell-metal. Several large grinding stones were used, having mouldings on their peripheries for restoring the dies when worn.

It is usual in England to soften the dies by annealing previous to restoring their shape, and again hardening them subsequently. The shape may be thus more perfectly restored, but at a greater cost, and the operation of softening and re-hardening deteriorates the quality of the steel.

12. *Cast Steel.*—The manufacture of cast steel is not carried on to any great extent. Some works have been started in Pittsburgh, which have hitherto met with great difficulties, but they are now more successful.

Workmen were obtained from Sheffield, but they were intractable, and failed to give satisfaction to their employers.

There were 2 converting and 9 melting furnaces, producing upwards of 2000 lbs. per day.

The steel sells at 17½ cents. per pound (8¾*d*).

13. *Engine Tools.*—The engine tools employed in the different works are generally similar to those which were used in England some years ago, being much lighter, and less accurate in their construction, than those now in use, and turning out less work in consequence.

The proportion of slide to hand lathes is greater than in the generality of English workshops.

Planing and drilling machines are commonly used; but there are comparatively very few horizontal or vertical shaping machines, and a considerable amount of hand labour is therefore expended on work which could be performed by machines much more economically.

The foundries are, for the most part, large and well arranged, and are furnished with good powerful cranes.

Great anxiety is now manifested by many manufacturers to have engine tools of a better description than those in use; and before long there will, no doubt, be great improvement in this respect.

CHAPTER III.

BUTTONS—DAGUERREOTYPE FRAMES—PINS—HOOKS-AND-EYES—CUTLERY, &C.

Waterbury.

14. *New Manufacturing Towns.*—The energetic character of the American people is nowhere more strikingly displayed than in the young manufacturing settlements that are so rapidly springing up in the Northern States.

A retired valley and its stream of water become in a few months the seat of manufactures; and the dam and water-wheel are the means of giving employment to busy thousands, where before nothing more than a solitary farm-house was to be found. Such, in a few words, is the history of Waterbury and all the Naugatuck settlements of Holyoke, Chicopee, Lowell, and Laurence. Many others might be mentioned, but allusion is now only made to those visited.

15. *Waterbury.*—Waterbury is situated in the Naugatuck valley, about 24 miles north of New Haven. It contains many manufacturing establishments, carried on principally by joint stock companies. Besides other firms, there are 28 companies of which the greater number are employed in the manufacture of rolled and sheetbrass, copper, wire buttons, German silver, pins, cutlery, hooks-and-eyes. The others are employed in manufacturing hosiery, felt, cloth, webbing, covered buttons, umbrella trimmings, leather, &c.

The official statements of these companies show that their respective capitals vary in amount to a very great extent, and that they are in some cases remarkably small :—

There are 2 with a capital of $6000 (about £1200).
5 between $10,000 (£2000), and $200,000 (£4000).
13 - - $20,000 - - - $100,000 (£20,000).
And the rest - - $100,000 - - - $253,000 (£50,000).

Great facilities are afforded in many of the States for the formation of manufacturing companies. The liabilities of partners not actively engaged in the management are limited to the proportion of the capital subscribed by each, and its amount is published in the official statements of the Company. In the case of the introduction of a new invention, or a new manufacture, the principle of limited liability produces most beneficial results. Persons who from their connections or occupations are likely to be interested in, or profited by, the new invention or manufacture, readily associate together and subscribe capital to give the new proposal a fair trial, when they are assured that their risk will not extend beyond the amount of which they may choose to contribute.

The cost of obtaining an act of incorporation is very trifling ; in one case where the capital of the company amounted to $600,000 (£120,000), the total cost of obtaining the act of incorporation was 50 cents (2*s.* 1*d*).

16. *Button Machinery, Buttons, &c.*—Upwards of 200 men are employed by one of the companies in the manufacture of buttons, hinges, daguerreotype plates and frames, &c.

The round-shaped button is formed by two punches, one working inside the other, each being driven by a separate eccentric, and the inside punch having the longer stroke. By this arrangement the disc is forced through the die, and drops into a box, thus saving the labour of picking out, which is necessary where a single punch and solid die are used.

The spindle of the polishing lathe in which the button is fixed whilst being burnished, makes 10,000 revolutions per minute.

17. *Daguerreotype Frames.*—The lathe in which the oval frames used as settings, for daguerreotypes, are turned, has an oval chuck, and a stationary cutting tool fixed to the slide rest, for "trueing out" the previously punched oval. Two milling tools are used, one for forming the bevilled edge, the other for ornamenting the face of the oval frame.

The milling tool, as it revolves, is allowed to swivel so as to accommodate itself to the oval. When the bevilled edge has been formed, the first milling tool is removed and another substituted while the work revolves.

One workman is able to turn, and ornament by milling, two gross of frames per day.

18. *Pin and Hook-and-eye Manufactory.*—No description of the machinery used in pin making can be given, as the process of "papering" is all that is permitted to be seen.

The pins are all papered by machinery; they are placed in a shallow feeding dish in an inclined position, so as to allow them to descend gradually as they are shaken by a quick vibratory motion. They fall from the spout of the feeding dish upon the centre of an inclined shallow trough, about 18 inches long, through which runs lengthwise a slit sufficiently wide to admit the shank of a pin, and yet suspend it by its head. It being a matter of chance, when a pin falls from the spout, whether it will drop into the slit or slide down the trough, a sufficient number are allowed to descend to insure the filling of the slit by those which happen to fall favourably.

The superfluous pins slide down into a box, from which they are again lifted from time to time to the upper feeding dish. The descending line of suspended pins is conducted by the slit (which is curved at its lower end) to a sliding frame which is worked by the woman who attends the machine.

The frame carries a dozen grooves, and in each of these a pin is deposited as it passes under the slit; the pins are thus arranged in a row, with their points all turned the same way. The sheet of paper for receiving them is placed by the attendant on a grooved table, and deep folds are pressed into it at equal distances, and into the cross ridges thus formed, a row of pins is pushed by the carrying frame at every thrust forward.

Under no circumstances whatever are strangers allowed to enter the rooms in which the pin-making machines are at work. The workmen employed are obliged to enter into a bond, and find two sureties, that they will not disclose anything relative to the machinery. The company preferred keeping their mode of operation a secret in this way to taking out a patent.

19. *Hook-and-eye Making.*—Three different descriptions of machines are employed in making hooks-and-eyes,—the wire being let in on one side of the machine, and a completed hook or eye dropped out on the other.

The machines appeared to make them at the rate of about 100 per minute.

About 80 hands are employed, who are said to make 1,200 packs of pins, each containing 3,360 pins, and 2,500 gross of hooks-and-eyes, per day.

20. *Cutlery.*—The cutlery and file works were conducted on a limited scale. Many beautifully finished knives were exhibited, and were said to command a higher price than those of a similar class imported from England.

The artizans are employed principally on piecework.

In the cutlery department a workman was pointed out who earned $70 (about £14) per month, while the earnings of others occupied on precisely the same kind of work only amounted to $30 (£6) per month.

Thus it will be seen that each workman does the best he can for himself, irrespective of others, and reaps the reward due to his superior skill and industry.

CHAPTER IV.

LOCKS—PORCELAIN-HANDLES—CLOCKS—PISTOLS AND GUNS.

Pittsburgh, New Haven, Worcester, Hartford.

21. *Lock making.*—The manufacture of locks appears to be rapidly extending. In an establishment at Pittsburgh employing 350 men in making locks, coffee mills, copying presses, &c., good work was being turned out.

Another at New Haven, Connecticut, employs about 200 men in making locks and lock-handles. The latter are made of coloured clays, so mixed as to present a grained appearance. They are first moulded by hand, then turned in a self-acting lathe with great rapidity, and are afterwards baked in a furnace.

Padlocks are made here of a superior quality to those of the same class ordinarily imported from England, and are not more expensive.

22. *Clock making.*—The celebrity attained by New England in the manufacture of clocks gave a peculiar interest to a visit to one of the oldest manufactories of Connecticut; 250 men are employed, and the clocks are made at the rate of 600 per day, and at a price varying from $1 to $10, the average price being $3.

The frames of the clocks are stamped out of sheet brass, and all the holes are punched simultaneously by a series of punches fixed at the required distances.

The wheels also are stamped out of sheet brass, and a round beading is raised by a press round their rims for the purpose of giving them lateral strength. They are cut by a machine having 3 horizontal axes, carrying each a cutter placed about 4 inches apart. The first cutter is simply a saw, and the second rounds off the teeth. In cutting an escapement wheel, the first cutter is made to cut each tooth entirely round, and then either the second or third axis with its cutter is used for finishing. The pullies on the three axes are driven by one driving pulley with three straps working over and in contact with each other.

The plates forming the clock faces, and other discs, are cut out by circular shears. The beaded rims intended to go round the clock faces, varying in size from 15 inches downwards, are stamped in concentric rings out of a disc, and then made of the required form by means of dies and a stamping press.

The ogee form given to the wooden framing of the common clock is formed by a revolving cutter of the required shape, making 7000 revolutions per minute, over which the piece of wood is passed by hand,—the requisite pressure downwards being given at the same time.

A circular cutter fixed on a horizontal axis is also used for roughly planing the back parts of the wooden clock. Its diameter is about 18 inches, and it has 4 lateral projections, carrying 4 cutters, 2 gouges, and 2 chisels. These revolve round a fixed circular centre plate, of about a foot in diameter, against which the work is pressed as it is passed along. Each clock passes through about 60 different hands: more than half of the clocks manufactured are exported to England, and of these a large portion are re-exported to other markets.

And it is worthy of remark, that the superiority obtained in this particular manufacture is not owing to any local advantages ; on the contrary, labour and material are more expensive than in the countries to which the exportations are made ; it is to be ascribed solely to the enterprise and energy of the manufacturer, and his judicious employment of machinery.

23. *Guns and Pistols.*—In a large manufactory at Hartford, from 400 to 500 men were employed in making revolving pistols at the rate of from 1200 to 1500 per week.

Self-acting machinery and revolving cutters are used for making all the separate parts, and the tools are made and repaired in a machine shop which is attached to the works.

In another establishment at Worcester, Connecticut, 175 men were at work, manufacturing guns, rifles, and pistols. Revolvers were made in large numbers with barrels on the old principle, and were all proved by hydraulic pressure.

Further particulars will be given respecting this manufacture when the Government establishments are noticed.

CHAPTER V.

WOOD WORKING.

Lowell, Buffalo, Philadelphia, Baltimore, Worcester, New Haven.

24. *Labour-saving Machines.*—In no branch of manufacture does the application of labour-saving machinery produce by simple means more important results than in the working of wood.

Wood being obtained in America in any quantity, it is there applied to every possible purpose, and its manufacture has received that attention which its importance deserves.

It would be difficult to point in any country to a more successful application of machinery to the working of wood than was made in England long ago in the manufacture of ship blocks, by the late Sir Isambard Brunell, aided by the late Mr. Maudslay: other instances of mechanism most ingeniously adapted to similar purposes might also be cited. It cannot therefore be said that in England nothing has been done in this branch of manufacture; but it must be confessed that the improvements which have been made have not been extended, as they might have been, to ordinary purposes, though in this respect a desire for progress is now evidently manifested.

A house in Liverpool is importing the best machines of the kind in use in America, and is making great efforts to introduce them generally in England.

25. *Saw Mills, Lowell.*—The trees sawn up in the Lowell saw mills are floated down from the interior of the country by river; they are docked in a basin in the timber yard, and are dragged up an inclined plane into the interior of the mill as they are wanted.

In an upper story are placed two large saw frames, and between them travels an endless chain, running along the shop floor over pullies, and extending down the inclined plane nearly to the edge of the basin. To any part of this endless chain may be hooked another chain, which, being passed round one or more trees as they lie in the basin, drags them up into the mill and deposits them alongside the saw frames.

Shingles, used for covering the roofs and sides of houses, are made in vast quantities.

A circular saw cuts them 16 inches long, from 3 to 9 inches wide, and of a thickness tapering from $\frac{3}{8}$ to $\frac{1}{8}$ of an inch, at the rate of from 7,000 to 10,000 pei day, according to the nature of the wood.

Timber is also cut up into laths 4 feet long, at the rate of from 60 to 100 per minute, by a circular saw attended by two men.

26. *Saw Mills, Buffalo.*—In these saw mills boards were sawn into "sidings," that is, long wedged-shaped boards for the sides or roofs of houses, by a circular saw at the rate of 17 feet per minute. The board is introduced at the back of the saw, and moves in the direction in which it revolves. It thus cuts with the grain, and the strength of the cut assists the forward feeding motion of the board.

Subdivision of manufacture is advantageously adopted as a system.

Many works in various towns are occupied exclusively in making doors, window frames, or staircases by means of self-acting machinery, such as planing, tenoning, morticing, and jointing machines. They are able to supply builders with the various parts of the woodwork required in buildings at a much cheaper rate than they can produce them in their own workshops without the aid of such machinery.

In one of these manufactories twenty men were making panelled doors at the rate of 100 per day.

Portable sawing machines, driven by horse-power, are commonly used for sawing up logs of wood for fuel, particularly at the various stations on the railroads, where the wood intended for the consumption of the locomotives is stored in piles.

The "horse-power machine" consists of a stout frame supporting a railway about 7 feet long, on which run the rollers of an endless travelling platform. The axles of the rollers are of iron, $\frac{5}{8}$ in diameter, stretching across the rails, and are connected together by a series of links, each about twelve inches long, so as to form an endless chain, which passes over a fixed segment at one end and the chain wheels at the other. The travelling platform is made by planks of wood about 12 inches broad, $1\frac{1}{4}$ inches thick, fastened transversely to the endless chain. It is inclined at an angle of about 7° to the horizontal line, and the horse being placed on the platform pushes it backward from under him, which causes the chain wheels at the end of the frame to revolve, and the motion thus obtained is conveyed to the circular saw or other machine required to be driven. Some horse-power machines are made to admit two horses abreast. They are found very useful to farmers; when requisite they are mounted on wheels, and may be easily taken from place to place to saw up trees which could not conveniently be moved entire.

27. *Planing Machines.*—A numerous variety of planing machines are in common use. For flooring boards, Woodworth's machine is found to answer very satisfactorily. In planing mills at Philadelphia, four of them were working in one room side by side; they have three cutters on each horizontal axis, having a radius of 6 inches, and making 4,000 revolutions per minute. The cutters are said to be capable of planing from 2,000 to 3,000 feet of work without being sharpened with the oil-stone, and from 20,000 to 30,000 feet without being ground.

They plane boards 18 feet long, varying in width from 3 to 9 inches, at the rate of 50 feet per minute. At the same time that the face of the board is planed, it is tongued and grooved by cutters revolving with a radius of about 3 inches, on vertical axes on each side of the board.

The chips made by the four planing machines are driven through large pipes, and fall into a trough about 20 inches wide, running across the room immediately under the cutters. In this trough works an endless chain, on which are fixed wooden scrapers that carry along the chips as they fall, to a recess at the side of the room. Here they are carried off by the scrapers of another endless chain running up an inclined plane. The pullies on which this side chain works are larger in dimensions than those of the transverse chain which works inside.

The transverse chain thus deposits its chips in the trough of the inclined plane, and they are carried up to a hole in the ceiling of the fuel room, adjoining the boiler house; through this hole they fall into the fuel room, and fill it up, if necessary, to the top.

28. *Daniel's Planing Machine.*—Where an accurately smooth surface is required, Daniel's planing machine is employed.

It consists of an upright frame, in which a vertical shaft revolves, having horizontal arms, at the ends of which are fixed the cutters.

The work is carried along on a travelling bed under the cutters, which are driven at a very high speed.

29. *Box Making.*—In a box manufactory at Worcester a machine, made on Woodworth's principle, planed boards 10 inches wide simultaneously on both sides.

Boxes are made in great numbers, from boards which are tongued and grooved by what is called a "matching machine," and then put together as that operation is finished.

The tonguing and grooving cutters are fixed on horizontal axes, and the workman passes the boards alternately over one or the other, as the sides require to be tongued or grooved.

Other varieties of planing machines are also in use, known by the names of their different inventors; some of them have fixed vertical or horizontal cutters, others vertical or horizontal revolving cutters, and various other combinations, according to the purposes for which they are intended.

30. *Spill or Match-making Machine.*—This machine makes 900 round spills, 15 inches long, $\frac{1}{8}$ inch diameter,

per minute; so that if each spill were cut into 5 matches, each 3 inches long, 4,500 would be produced every minute.

The spills are cut from pieces of straight-grained timber, made of such a length as to pass between two grooved feeding rollers, which hold the timber so that its under surface is level with the lowest parts of a row of tubular cutting tools, or long sharp-edged punches.

The cutting tools are thus arranged: 5 pieces of steel are fixed side by side in a horizontal bar. Each piece of steel is perforated with 3 long holes, lying close together, and having their ends sharpened like the cutting edges of a hollow punch. A line of 15 tubular cutters is thus formed, and motion is given to the horizontal bar, in which they are fixed by a crank which impels them against the timber. This is depressed at each stroke sufficiently to allow each cutter to cut out its spill, which passes through and falls out behind.

The cost of this machine would not exceed 20*l.*, and when the number of matches, all nicely rounded, which it is capable of producing, is contrasted with the number which could be produced by a hand-instrument in the same time, it will serve as a simple and striking illustration of the advantageous employment of matter in the form of machinery to do the work of man.

31. *Last and Boot-tree Manufactory.*—A machine, constructed on Blanchard's principle, is used for making lasts.

A pattern last, and the block of wood from which another last is to be cut, are fixed upon, and revolve round, a common axis, being connected with the centres of a headstock fixed on a frame made to oscillate from below. As the pattern revolves it is kept continually pressed against a knob of iron by a spring, and as the block of wood revolves it is shaped by a circular cutter, revolving on a fixed axis, with its cutting edges in a line with the face of the knob. The pattern and the copy revolving simultaneously on a common axis, as the surface of the pattern is pressed against the projecting knob, the oscillating frame is made to move, so that the revolving cutters shape from the block a surface exactly corresponding to the surface of the pattern, and the copy occupies relatively to the cutters the same position which the pattern does relatively to the knob of iron.

About 18 men are employed, who make 100 pair of lasts per day, exclusive of boot-trees.

32. *Furniture Making.*—Labour-saving machines of all kinds, sawing, planing, boring, shaping, and jointing machines, are very advantageously employed in the manufacture of furniture. An apparatus of a very simple character is used for shaping the arms and legs of chairs.

Two vertical cutters are made to revolve in opposite directions, at the rate of about 1,700 revolutions per minute, on axes projecting above a bench.

The cutters are about 4 inches in diameter, and between them and the bench are loose washers or rollers, against which the pattern to which the work is fastened is pressed so as to guide the cut.

The cutters revolve in opposite directions, and the work may be pressed against either one or the other, so as to suit the cut to the direction of the grain of the wood, without the workman having the trouble of reversing its position.

33. *Agricultural Implements — Ploughs.* — Labour-saving machines are most successfully employed in the manufacture of agricultural implements.

In a plough manufactory at Baltimore eight machines are employed on the various parts of the woodwork.

With these machines seven men are able to make the wooden parts of 30 ploughs per day.

The handle pieces are shaped by a circular cutter, having four blades, similar to those of smoothing planes, fixed on a horizontal axis, with about 2 inches radius, and making nearly 4,000 revolutions per minute. The work to be shaped is fastened to a pattern, which is pressed against a loose roller on the axis of the cutter as the workman passes it along, and it is thus cut of exactly the same shape as the pattern.

All the ploughs of a given size are made to the same model, and their parts, undergoing similar operations, are made all alike. Some of the sharp edges of the wood are taken off or chamferred by a cutter revolving between two cones; these guide and support the work as it is pressed down edgewise on the cutters, and passed along by the workman.

34. *Ploughs—(continued).*—The other machines in use consisted of a circular and vertical saw, and machines for jointing, tenoning, drilling, and for making round stave rods, and giving them conical ends, the whole being of a simple and inexpensive character.

The curve handle pieces of the ploughs, which require to be steamed and bent, are obtained already shaped from the forests where they are cut, and are advantageously supplied to the large manufacturers. The prices of the ploughs vary from $2½ to $7.

The price of Pig-iron in Baltimore was $40 per ton.

Pine timber - -	$20	per 1,000 feet.
Ash - - -	$24	,,
Oak - - -	$25	,,

35. *Mowing Machines.*—In a manufactory at Buffalo, mowing machines were being made in large numbers, 1,500 having been supplied this summer. Two were in operation in a field a short distance from the town; each was drawn by 2 horses, and could mow on an average 6 acres of grass per day.

The machine is similar in its construction to the common reaping machine, but it has only one wheel, furnished with projections to prevent it from slipping. This wheel gives motion to the cutters, and supports one side, the other rests on a runner like that of a sledge. It has a pole to which two horses are attached in the ordinary way, and the driver sits on a seat fixed behind the cutters.

36. *Churn Making, &c.*—In an establishment at Worcester, 250 hands are employed principally in making ploughs, hay-cutters, churns, &c.

Templates and labour-saving tools are used in the manufacture of these implements, which are sold in very large numbers.

The churns consist of a double case, the inner one being of zinc, which receives the milk or cream, and in which the arms revolve, the outer one being of wood. It is found by experience that butter is formed most rapidly when the milk or cream is churned at a certain temperature, and in order to obtain this temperature, which is indicated by a thermometer inserted in the churn, warm or cold water is introduced between the inner zinc and outer wooden casing, as may be required.

37. *Carriage Making.*—Many of the carriages, especially those technically called "waggons," are made of an exceedingly light construction, and are intended generally to carry two and sometimes four persons.

Their wheels are frequently made with only two felloes, which are bent round by the operation of steaming, and are strengthened at the joining with iron clamps. The wheel of a carriage constructed to carry four persons had felloes only 1½ inches square. They are generally made of white oak, and the spokes are obtained ready shaped from shops where their manufacture forms a special trade.

It would seem as if the elasticity of these carriages peculiarly fitted them for the very bad roads on which they in general have to run, and it is evidently a principle with the Americans to use up their light carriages and save their horses.

Every man in America who is able to keep his waggon is free to do so, unfettered and unquestioned, consequently their use is so general that it may be said to be almost universal. Their manufacture is one of great importance, and supports a vast number of wheelwrights and artizans of that class, who from the nature of their employment attain great skill and aptitude, enabling them to turn their hands to almost any variety of work, and rendering them a most useful and important class.

CHAPTER VI.

STONE-PLANING WORKS—BRICK MAKING FROM DRY CLAY.

Staten Island, New York, Washington.

38. *Stone-planing Machines.*—In an establishment at Washington, which has but recently commenced operations, there were two planing machines and a grinding or polishing machine. Considerable difficulties have hitherto attended the employment of machinery for planing stone such as granite, and stone of similar formation.

These difficulties have, however, been surmounted most successfully by the construction of planing machines such as are used in stone works in New York and Washington, in the former of which upwards of 400 men and 10 machines are employed.

The planing machine consists of an upright frame, in which revolves a vertical shaft, carrying 3 horizontal arms. At the extremities of these arms, are fixed circular cutters inclined outwards about 45° from the perpendicular, or about the angle at which the workman would hold his chisel. They are about 10 inches in diameter, and $\frac{3}{4}$ inch thick, made of steel, and bevilled on both sides, leaving a sharp edge. They are fitted upon axes, and are at liberty to revolve loosely in their bearings as their edges strike the stone.

The cutters are carried round by the shaft at the rate of about 80 revolutions per minute when planing freestone, and 60 when planing granite.

The stone is moved forward on a bed to which it is keyed; the cutters strike its surface obliquely as they are carried round on the revolving arms, turning at the same time on their own axes, and chipping and breaking off the projecting portions of the stone at every cut.

The machine planed the face of a stone slab, 4 feet long and 2 feet wide, in seven minutes.

Another modification of this machine, which is not so economical, is employed when it is necessary that the face of the stone be left in lines as it came from the tool.

The stone is keyed on a travelling bed, and passed under a frame, in which works a sliding carriage driven by a crank; in this carriage is fixed the circular cutter at the required angle, and as the stone is carried along, the cutter is driven backwards and forwards across its face at right angles to the direction in which it moves, and chips off parallel breadths of stone at every cut.

The cutters can be used for planing from 300 to 400 square feet of freestone surfaces, and about 150 square feet of granite, without being ground.

39. *Stone Polishing Machine.*—The stone is polished by a flat circular disc of soft iron which is made to revolve horizontally. The axis of a disc is fixed at the end of a heavy frame, which moves round a strong centre shaft in a radius of about 12 feet.

The polishing disc revolves at the rate of 180 revolutions per minute. It is driven by a strap to which motion is given by a driving pulley fixed on the centre shaft. The disc is guided, and its pressure regulated by hand. It will polish about 400 square feet of surface in a day of 10 hours.

40. *Brick Making with Dry Clay.*—A machine for making bricks from dry clay was in operation on Staten Island, about nine miles from New York. The works are carried on under extensive sheds, near to the water side, and are connected with a wharf by a railway, which also extends to the bed from which the clay is dug. A large moveable shed is erected on the bed of clay at the terminus of the railway.

In dry weather the clay is collected by slicing it from the surface with a kind of shovel having a sharp edge, which is drawn by two horses, and will hold about two barrowsful.

In wet weather the surface of the clay is harrowed to the depth of 2 or 3 inches by a triangular wooden frame carrying 9 teeth, a process which in the powerful rays of an American sun soon causes the moisture to evaporate. It is then taken off by the scoop or shovel above described, and conveyed to the shed, whence it is carried by rail to the machine shed. It is deposited close to a cylindrical screen, revolving on a fixed axis, which has projecting loose bars. The screen is about 8 feet long and 3 feet in diameter, and consists of bars $\frac{5}{8}$ inch square, rivetted on two cast-iron wheels, which form the ends; the bars are about $\frac{1}{16}$ inch apart, and the clay is riddled through them. The screen is inclined, and the clay is fed in between the arms of the wheels, and as it revolves the small pulverized particles fall through the bars, while the large stones pass out at the lowest end.

The clay is next raised by elevators, which are fixed to an endless leather belt about a foot wide, to the height of about 12 feet, and conveyed to rollers. It is ground and shovelled into hoppers which feed the moulds; these are 8 inches long, 4 inches wide, and 4 inches deep.

The clay is dropped into the moulds, which are placed six in a row to the depth of 3 to $3\frac{1}{4}$ inches, according to the quantity of moisture it contains, and is afterwards compressed to the thickness of 2 inches in the following way.

Six presses or rams, fixed in a heavy frame, are raised by a cam, and being allowed to fall, exert very great pressure by their impact on the clay. The blow is repeated, and then the bricks are powerfully compressed above and below by revolving cams: 36 bricks are made per minute. They are at once conveyed to the kiln, which is under the shed at a short distance from the machine.

After being burnt, they are separated into three shades of colour, of light and deeper reds. The best burnt bricks are equal in quality to the best English stocks, and were selling at $12 per 1000.

41. *Brickmaking from Dry Clay*—(*continued*)—In a brick yard at Washington, Sawyer's machine, which had been in use for 16 years, makes about 1800 bricks per hour from dry clay, by compression only.

The clay is obtained from a pit close by. As it is dug out it is carted up an inclined plane to the floor over the room where the machine is at work.

A roller weighing 1600 lbs., and making 60 revolutions per minute, grinds it upon a grating through which the pulverized particles fall into the room below.

There it is shovelled into a hopper which supplies the brick moulds by feed-pipes. Three bricks are made at one time, being compressed by top and bottom pistons or pressers, which are connected together by long iron rods, and from the top part are suspended levers, with toggle joints worked by cranks. The bricks were sold at the rate of $6½ per 1000, and were of a medium quality between English seconds and stock bricks.

CHAPTER VII.

INDIA RUBBER MANUFACTORY—FISHING-NET MAKING MACHINE—FLOUR MILLS—ELEVATORS.

42. *India Rubber Manufactures.*—India rubber is applied to a great variety of purposes, and its manufacture here is attended with very great success.

By a new process of hardening, the substance becomes of the consistency of horn. In that state it is manufactured into combs, walking sticks, and other articles.

43. *India Rubber Overshoes.*—The India rubber in its rough state is first cut up by shears into small pieces. It is then put through a machine similar to that used for tearing and cleaning rags intended to be made into paper. The water used in the operation is drawn off from time to time through a wire grating.

The material thus chopped up, and cleaned, is passed through rollers, where it is sufficiently ground. It is then put through other rollers, where it is kneaded, and worked up with the necessary composition.

The India rubber, so mixed, is passed in the form of an endless web through 4 rollers placed vertically one above the other, and comes out a broad web fit for use.

The "gumming process" is performed by three rollers, Nos. 1, 2, 3. Nos. 1 and 2, the two lower ones, revolving side by side, and No. 3 revolving above and in contact with No. 2. The India rubber is fed between Nos. 1 and 2, and the cloth to be gummed or covered is passed betwen Nos. 2 and 3, taking up from No. 2 a thin and equally spread coating of rubber.

The India rubber cloth is cut out from the sheet by workmen, in the shape required to form shoes. The parts so shaped are put together by women, who form them on lasts, closing the joints by cohesion after touching them with camphine. Each woman finishes an entire shoe, and about 1400 pairs are made daily.

The shoes are then covered with a coat of varnish, and taken to the stove drying room, where they are subjected to a heat of from 250° to 280°, and allowed to remain a night.

To provide for an equal distribution of heat in the drying room, two large heating stoves are placed underneath, each in a separate compartment. These are fed with fuel from the outside, and the heat is admitted into the drying room above, through several apertures pierced in the floor.

Thermometers are placed at the side of the room, and can be inspected through glass from the outside.

44. *Fishing Net Machines. — Baltimore.* — These machines combine the general features of the power loom and the lace machine.

They are made from 6 to 7 feet wide, according to the size of the mesh. One machine nets a $\frac{3}{4}$-inch mesh, and can be used for netting meshes of $1\frac{1}{2}$ inch and $2\frac{1}{4}$ inches. It works at the speed of 12 picks per minute, and a complete course of 100 knots is made in the width of this machine, at each pick of the shuttle.

One woman can do the work of upwards of 100 hand netters. The meshes are made rectangular, in the direction of the length of the net, and not diagonally, as in hand-made nets. The cost of the machine is $800 (about £160).

The manufacture of sailcloth is carried on in the mill where these machines are at work.

The throstles for spinning yarn for the sailcloth spin 6 hanks to the pound. The carding engine sliver is carried by the railroad system along a trough to the drawing frame. The main cylinder of the carding engine is 36 inches in diameter, and the doffing cylinder 13 inches, the former making 135 revolutions and the latter 7 revolutions per minute. In the fly-frame the front roller makes 200 revolutions per minute, and the flyer from 1,900 to 2,000.

By some shipowners sailcloth made of cotton is preferred to that made from hemp.

Fishing nets made by hand are here also manufactured of cotton.

45. *Corn and Flour Mills—Pittsburgh.*—These mills employ 40 persons, including clerks and all others engaged in the various departments, and are capable of producing 500 barrels of flour per day, each containing 196lbs.

The grain is brought in bulk in boats alongside the building, and is raised by an elevator consisting of an endless band, to which are fixed a series of metal cans revolving in a long wooden trough, which is lowered through the respective hatchways into the boat, and is connected at its upper end with the building where its belt is driven.

The lower end of the trough is open, and as the endless band revolves, six or eight men shovel the grain into the ascending cans, which raise it so rapidly that 4,000 bushels can be lifted and deposited in the mill in an hour.

The grain is next allowed to descend by a shoot or trough (the descent being regulated by traps) into a large hopper, resting on the platform of a weighing-machine; its weight is then registered, and afterwards, by drawing a trap in the bottom of the hopper, the grain is allowed to descend by another shoot to a lower story.

It is next raised by an elevator to the highest story of the mill, where it is cleaned by passing through three different machines. The greatest care and attention is bestowed on this process, in order to insure the perfect cleansing of the grain preparatory to being ground.

The grain is then conducted to the stock-hoppers, which feed eight pairs of grinding-stones.

A short length of the feeding-pipe of each pair is made of glass, through which the grain, as it descends, can be seen. The stones are 4 feet in diameter, and make 232 revolutions per minute.

The meal, when ground, is conveyed by means of a spiral conveyor to the cooling chamber, where a rake, revolving horizontally, is substituted for the old "hopper boys." The meal is raked from the circumference to the centre, where it falls through a hole and is taken to the bolting machine; it is there sifted, and separated into different qualities of flour. It is then conveyed to hoppers, from which it descends by spouts into the barrels in which it is packed.

46. *Elevators.*—The business of unloading vessels is followed as a special trade.

On the wharves in Buffalo may be seen in many places large signs announcing that elevators are kept for hire.

They are used for raising grain from vessels, storing it in warehouses, and transferring cargoes of wheat from one vessel to another, the grain in the last case being raised by the elevator cans and then allowed to descend by a trough or shoot which guides it in any required direction.

CHAPTER VIII.

MANUFACTURING COMPANIES—CIVIL ENGINEERING—COTTON MILLS—CARPET MANUFACTORY—WOOLLEN AND FELT CLOTH MAKING—SEWING MACHINERY—COTTON GIN.

Lowell, Lawrence, Holyoke, New Haven, Waterbury.

47. *Textile Fabrics.*—The manufacture of textile fabrics is extending, particularly in the New England States.

Many new towns, founded for the purpose of carrying on this branch of manufacture, have in a short time attained considerable importance.

48. Lowell, Lawrence, and Holyoke, in Massachusetts, may be cited as instances well worthy of notice.

Lowell is situated on the banks of the Merrimack, about 25 miles north of Boston. It contains twelve large manufacturing establishments, belonging to different companies; of these, eight manufacture cotton goods, possessing in the aggregate about 350,000 spindles and 10,000 looms, and employing about 7,000 women and 2,000 men.

Two of them manufacture woollen goods, carpets, rugs, and broadcloths (one also combines the manufacture of cotton goods to some extent), possessing about 20,000 spindles and 600 looms, and employing about 1,500 women and 1,000 men.

One is a bleaching concern, employing 250 men.

One a machine shop, employing 700 men.

49. The capital stock of the companies varies in amount from $300,000 (£60,000), to $2,500,000 (£500,000); the total for the whole being $14,000,000 (£2,800,000).

The interiors of the mills are kept in a state of great cleanliness. The rooms are lofty and properly ventilated: their white ceilings and walls, combined with the blue hangers and columns, have a pleasing appearance.

The courtyards of many of the mills are laid out with flower-beds, interspersed with shrubberies, or shaded by lofty trees, and great care seems to be taken to keep them in good order.

50. Water power is used for driving the machinery in all the mills. It is obtained by means of a large and deep canal which is cut from the river at some distance above the town.

At the head of the canal, where it joins the river, are floodgates, worked by large screws, all of which are driven by a small turbine. The masonry of the canal is constructed of blocks of granite, some of which are of very large dimensions.

The water thus conducted by canal is employed by the various companies in driving powerful turbine water-wheels. The mill gearing, conveying the power from the turbine to the different parts of the mill, is exceedingly well constructed.

The civil and mechanical engineering works, employed in adapting water power to driving the machinery of the Lowell mills, have been most ably executed.

51. The first mills commenced operation in Lowell in 1823. Eight of the companies have been founded since 1830.

In 1828 the town contained 3532 inhabitants: in 1850 its population was 33,385 !

It has four banks and two institutions for savings, and a hospital established by the several companies for their sick operatives.

52. *Lawrence.*—Lawrence is situated about 26 miles north of Boston, on the Merrimack river, 9 miles below Lowell.

The first dwelling-house was erected in September 1845, and in 1850 the town contained 8500 inhabitants, and upwards of 1000 dwellings. There were 15 schools, attended by 1000 scholars, and conducted by 16 teachers.

The town now contains upwards of 13,000 inhabitants.

53. *Water Power.*—The water power was obtained by building a dam which has a 25 feet fall of water, 900 feet broad.

The dam is constructed in the form of a curve of solid masonry, imbedded in and bolted to the rock. It is 35 feet thick at the base, and averages 32 feet in height. Its cost was $250,000 (about £50,000).

The water is taken from the river above the dam by a canal just a mile in length, 100 feet broad at its upper end, and 60 feet broad at the lower, 12 feet deep in the middle, and 4 feet at the sides. Its total cost, including locks and other structures connected with it, was $200,000 (about £40,000).

54. *Cotton Mills.*—Seven large incorporated manufacturing companies have already commenced operations, and others are about to be established.

The largest cotton mills employ about 1200 hands.

They have a frontage of 600 feet, and consist of a centre block of six stories 106 feet wide, and two wings of five stories, 64 feet wide.

The machinery is driven by three turbine water-wheels, 8 feet in diameter.

55. *New Cotton Mill.*—Another establishment, lately erected, is now being fitted with machinery for the purpose of manufacturing mousselines de laines, barèges, and other light fabrics.

It is six stories high, each averaging 13 feet, 750 feet long, and 72 feet wide. There is also another building in the course of erection which will be 1200 feet long, two stories high, with two wings, each 200 feet long and three stories high, and is intended to be used for printing, dyeing, &c. These mills are built of good bricks, measuring each 8 inches by 4 inches and 2 inches thick.

The contract price for laying 1000 bricks, including cost of material, is £1 16*s*. The entire erection was found to cost 50 cents (or 2*s*. 1*d*.), per square foot of flooring laid down.

The wool-combing machinery will be obtained from England. One woman working one of these machines, will be able to comb 1,000lbs. of wool per day, while a skilled hand wool-comber is only able to comb from 8 to 10lbs. in the same time.

The machinery of these mills will be driven by turbine water-wheels, of between 500 and 600 horse power in the aggregate.

56. *Woollen Factory.*—The mills of this establishment are built in the form of a parallelogram, round three sides of which run buildings from three to five stories high. The front is formed by three detached mills, each 200 feet by 48 feet, and 9 stories high, including attic and basement.

2,300 hands are employed in the manufacture of cassimeres, shawls, felt cloth, and other woollen goods.

57. *Felt Making.*—The whole waste from the mills mentioned in the preceding paragraph, is worked up in the manufacture of felted cloth.

The felt-making machines occupy but a small space. A sliver of wool is taken from the carding engine and passed between two endless cloths; these carry it over a narrow steam box, where it is steamed, and it is then passed under a vibrating pressing-plate, which operations cause the fibres to curl and interlace with each other, and so form a cloth.

The machinery of these mills is driven by seven breast wheels, each 26 feet in diameter.

58. *Machine Shop.*—There is a large machine shop employing 500 hands in the manufacture of spinning and other machinery.

It is 4000 feet long, 64 feet broad, and contains four stories of from 16 to 13 feet high. The forge shop is 230 feet long, 53 feet wide, and 17 feet high, and contains 32 forges. The foundry is 150 feet long, 90 feet wide, and 22 feet high.

59. *Holyoke—Cotton Mills.*—Holyoke is a manufacturing town situated on the banks of the Connecticut river.

A short notice of its history will serve to explain the way in which manufacturing companies are established in the United States.

In 1847, a company was formed for the purpose of turning to account the water power supplied by the river Connecticut, buying up the water privileges, and purchasing land to form the site of a manufacturing town.

The company subscribed a capital of $4,000,000, and was incorporated by the State of Massachusetts in 1847.

It succeeded in obtaining the water privileges, and upwards of 11,000 acres of land, besides other tracts in the vicinity. A dam, more than 1,000 feet long, was constructed across the river, in the summer of 1849.

The site of a town has been laid out with streets from 60 to 80 feet wide, calculated for a population of 200,000 inhabitants. It contains already upwards of 5000 inhabitants, and it is officially stated, that the average sum appropriated for the education of each child was in 1852, $3 72c.

There is a 60 feet fall of water, which can be used by two sets of mills on different levels, affording power sufficient to drive the machinery of 100 large mills.

60. *Cotton Mills.*—Two cotton mills employing 1,100 hands, a machine shop employing 365 hands, and a paper mill are already at work; others are in the course of erection.

One of the mills was spinning yarn, Nos. 70 and 90, and making it into cloth of excellent quality.

Self-acting mules were used, and twelve piecers were minding 13,056 spindles: three hanks per spindle were spun in a day of 11½ hours.

One girl is able to weave of this yarn on four looms, 100 yards per day. Upwards of 70 girls were brought from Scotland a short time ago.

The machinery is driven by turbine wheels.

In some mills, gearing is employed for driving the heavy shafting, but generally belts are much preferred; of these, some had a breadth of 20 inches, and were driven at the speed of nearly 1800 yards per minute.

In some cases, in order to obtain sufficient adhesion, without having recourse to too tight a belt, the pulley is covered with leather, which is put on with white lead, and fastened with copper rivets.

61. *Hosiery.*—A large establishment at Waterbury is occupied exclusively in the manufacture of under-vests and drawers. The cloth waistbands of the latter are stitched by sewing machines, working at the rate of 430 stitches per minute. These machines have been worked with entire success for the last eighteen months.

The manufactured goods and the sewing machines are all that are shown to visitors. No stranger is ever permitted to see the hosiery looms; workmen, directors, and president all enter into a bond not to disclose anything connected with the machinery of the company.

62. *Shirt Making by Machinery, New Haven.*—In a shirt manufactory at New Haven, entire shirts, excepting only the gussets, are sewn by sewing machines.

By the aid of these machines one woman can do as much work as from twelve to twenty hand sewers. The workwomen work by the piece, and are frequently able to finish their estimated day's work by two o'clock, and when busy, work overtime.

63. *New Cotton Gin.*—This gin has, instead of saws, a card cylinder 8 or 9 inches in diameter, covered with coarse wire teeth, with considerably more bend or hook than the ordinary card tooth. The cylinder revolves against a spirally fluted cast-iron roller, the tooth being about $\frac{1}{10}$ inch, and the space between the teeth $\frac{3}{10}$ inch broad.

To save the expense of turning and fluting the roller, it is cast in lengths of about six inches, which are bored and turned at the ends, and then put together, the tooth and space being left as they are cast.

In contact with the card cylinder, a cylindrical brush, 28 inches diameter, is made to revolve. The card cylinder makes 200 revolutions, the fluted stripper 400 in a contrary direction, and the cylindrical brush 800 revolutions per minute.

When the raw cotton is introduced with its seeds between the card cylinder and the stripper (which are placed so far apart as to stop the seeds from passing), the hooked teeth of the card take hold of the fibres and pull them from the seed, which is held up against the roller as long as any fibres cling to it for the card teeth to hold by: the seeds are then released, and fall to the ground. The spirally fluted roller causes the position of the seed and cotton to be continually changing.

The cotton fibres, as they are taken round by the teeth of the card cylinder, are brushed off by the rapid revolution of the cylindrical brush, and carried to the bin.

The machine is about 60 inches wide, and can gin 1,500 lbs. of cotton per day. Its cost is $350 (£70).

CHAPTER IX.

RAILWAYS—RAILWAY CARRIAGES—LARGE FOUR-MASTED SHIP—FIRE COMPANIES—FIRE ENGINES.

64. *Railways.*—In the construction of railways, economy and speedy completion are the points which have been specially considered. It is the general opinion that it is better to extend the system of railways as far as possible at once, and be satisfied in the first instance

with that quality of construction which present circumstances admit of, rather than to postpone the execution of work so immediately beneficial to the country; to the future is left further progress and improvements.

A single line of rails nailed down to transverse logs, and a train at rare intervals, are deemed to be sufficient as a commencement, and as traffic increases, additional improvements can be made.

65. *Railway Crossings.*—Bridges are seldom thought necessary to carry the common highways across the railroads where they intersect, gates are even in many cases dispensed with, and a notice of "Look out for the locomotive when the bell rings" is considered a sufficient warning, and wayfarers are left to take care of themselves. Sharp curves and steep inclines are frequently submitted to for the sake of economy.

66. *Railroad Inclines.*—The railroad that connects the eastern and western parts of Pennsylvania, bringing the towns on Lake Erie, and the great western rivers into direct communication with Philadelphia and the Atlantic, consists at present of a single line of rails carried over the lofty ridges of the Alleghany Mountains by a series of inclined planes.

These are five in number, and the summit of the highest is 2,600 feet above the level of the sea. The trains are dragged up each incline by a rope attached to a drum worked by a stationary engine.

They are drawn across the plateaux which intervene between the inclines, in some cases by horses, in others by small locomotives. A new road is, however, being constructed which will cross the mountains by one long winding incline. The ascent will be so gradual in its circuitous course, that a locomotive will be able to ascend and descend with its train of carriages.

It is calculated that four hours will be saved by the substitution of this new route, and the dispensing with the stationary engines.

It is doubtful whether the delay would not have been very considerable, had the construction of the railroad been postponed until means had been found for executing these great works in the first instance.

67. *Street Railroads.*—It is a common practice to detach the carriages from the engine at the outskirts of towns, and draw them by horses along rails laid down in the streets.

Many objections may be made to this system, and it seems on the whole disadvantageous; a circuit of rails carried round the town would be more preferable.

68. *Railroad Cars.*—The construction of the railroad cars or carriages commonly used in the United States has been frequently described.

They are very long, and are supported at each end on four-wheeled trucks, on which they swivel when turning the sharp curves, which are of ordinary occurrence.

A car constructed for 60 passengers measured 40 feet long, 8½ feet wide, and 6½ feet high, inside measure; small benches with reversible backs, having each two seats, are ranged parallel to each other down both sides of the carriage, leaving a passage clear from the door at one end to that at the other. The car afforded upwards of 2,200 cubic feet of space, or 37 feet per passenger. Its weight was 11 tons, giving a dead weight of about 3½ cwt. per passenger.

The cost of a 60 passenger car is about $2,000 (400*l*).

A contrivance has been lately tried for excluding the dust by connecting the different carriages together by india-rubber curtains at the ends, the air being admitted through the roof of the first carriage.

The object sought to be obtained is, a current of air running through the entire train, and always setting outwards from the interior of the carriages. The results did not appear to answer fully the expectation which had been formed.

69. *A Four-masted Clipper Ship.*—A large clipper ship of 4,000 tons was being built at Boston; the length of keel was 287 feet, length on deck 320 feet, extreme breadth of beam 52 feet, and depth of hold 30 feet. Her keel is of rock maple in two thicknesses, the frame is of seasoned white oak, dowelled, and bolted together through the dowelling with 1¼ inch iron. The frame inside is diagonally crossbraced with iron, the braces

being 4 inches wide and $\frac{3}{4}$ inch thick, bolted through every timber: these braces extend from the floor-heads to the top timbers, and form a perfect network of iron over all her frames fore and aft.

She has five depths of mid-ship keelsons, each 16 inches square, three tier of sister keelsons, 15 inches square, bolted vertically and horizontally. There are four tiers of bilge keelsons on each side, 15 inches, square. Ceiling from bilge to lower deck 15 inches scarped and bolted edgewise.

She has three full decks, securely fastened with fore and aft knees; the hanging knees are extra fastened, having in the lower hanging knees 18 bolts, $1\frac{1}{4}$-inch iron; middle deck, 20 bolts; also upper-deck hanging knees, 20 bolts, and all of oak. Beams in lower deck 14 by 16, in middle deck 15 by 17, in upper deck 12 by 16, and some 12 by 20 inches. Lower deck main hatch is 14 by 20, middle deck 14 by 16, and main deck 14 by 11.

She has a hurricane-deck over all, merely for working the ship, thereby obviating the difficulty in obstructions from houses, spare spars, water casks, &c.

Her main mast is 126 feet long, 98 above deck, diameter 44 inches; masts built of hard pine, to carry two stationary yards with trusses, the same as used on lower yards; fore and main deck alike, and those on the mizen-mast the same as those on the other masts above the lower yards, so that except the courses all her sails will have duplicates on every yard fore and aft. Her main yard is 110 feet long, the others in proportion; she will have a fourth mast, principally to lead the mizen-braces, to prevent the difficulty arising from mizen-braces leading forward, and hauling the mast out of place.

The model of the ship was said to promise a combination of swiftness, buoyancy, and beauty that has never been excelled. Notwithstanding her vast size, such is her length and buoyancy that when loaded ready for sea her draught of water will not exceed 23 feet, a common draught for ships half her size.

70. *Fire Companies.*—The fire companies are formed

in many towns of volunteers, who do not receive pay, but enjoy certain immunities from taxes and militia service.

The parade-day of the fire companies of a town is considered as a fête, the companies of other towns are invited to attend, and test the qualities of their respective engines in a trial as to which can throw the highest stream of water. At a meeting of firemen, held in New Haven, 36 companies attended, each dressed in a distinctive uniform, and averaging about 50 strong.

A prize was given to the company whose engine succeeded in throwing the highest stream of water.

The engines played against a pole 150 feet high, through hose 450 feet long. Two engines, one having a 10-inch, the other an 8-inch cylinder, threw a stream 143 feet high, and carried off each a prize. These engines, however, were surpassed the following day by another engine with a 10-inch cylinder, which threw a stream over the pole.

CHAPTER X.

GOVERNMENT WORKS.

New York, Boston, Washington, Springfield.

71. *Navy Yard, New York.*—This navy yard is situated on Long Island, opposite the city. It covers a considerable extent of ground, and has many large storehouses and workshops, and gives employment to between 400 and 500 men.

It contains the most capacious dry dock in the United States, constructed to admit vessels of the largest size.

They may be completely docked, and the water pumped out, in four hours and a quarter. The quantity of water to be removed is about 610,000 cubic feet. It is pumped out by a condensing engine, with a 50-inch cylinder 12 feet stroke, and 32 feet beam.

The cut-off motion is self-adjusting, so that more steam is admitted into the cylinder as the height to which it has to pump the water increases.

The framing of the engine is in the form of Gothic columns, supporting arches, all painted and bronzed. All the work not painted is highly polished.

The whole is surrounded by a bronzed rail, and a cast-iron flooring, ornamented with stars in relief, covers the floor.

The engine-house is about 60 feet square, and 50 feet high. The boilers are placed in a fire-proof room adjoining; they are three in number, 26 feet long, 7 feet in diameter, and are ordinarily used at a pressure of 50 lbs.

The engine works two draining pumps, each 63 inches in diameter, having 8 feet stroke, one being connected to each arm of the beam.

The whole cost of the dock and its appendages is estimated at $2,000,000 (about £400,000).

72. *Navy Yard, Washington.*—In this yard there are from 500 to 600 men in the various departments, employed in the manufacture of ordnance, marine engines, chain cables, anchors, &c.

Experiments were being made with a large gun carrying 240 lbs. shot, and also with a pendulum mortar.

The quality of the metal of which each gun is composed, is tested and registered, and a sample piece preserved.

73. *Boston Navy Yard.*—The Boston Navy Yard is of great extent, and contains three large sheds for shipbuilding, one of which is now used as a store for timber; another is occupied by the ship "Virginia," which has been on the stocks for more than 20 years; the third is empty. The manufacture of rope is carried on on a very extensive scale. A building 1,360 feet long, contains a rope walk where a length of upwards of 1,200 feet of rope may be made. They have also the means of making 24-inch cables.

A set of machinery is used for making sheaves for ship blocks. An ingenious machine was employed for boring the sheaf, and recessing it on both sides for receiving the bush. Two lathe headstocks are mounted on a frame, and carry the small revolving cutters for making the recesses. An universal concentric chuck with three "jaws," having a large hole in its centre, is mounted between the headstocks. This carries the work, and has a vertical adjustment.

74. *Springfield Armoury.*—Springfield Armoury is beautifully situated on an eminence overlooking the town. The various buildings together form a quadrangle; the grounds, which are tastefully laid out, occupy an extent of about 40 acres.

I was conducted over the establishment by the Commanding Officer, Colonel Ripley, and the master machinist, Mr. Buckland, who is the inventor of the principal machines employed in the manufacture of fire-arms.

The front building, which has a handsome centre tower, is used as an arsenal for muskets. It contains 100,000 muskets, stacked with beautiful uniformity.

The barrels are made in mills, situated on the banks of a small river at some distance. The lighter parts of the musket, as the stock, the lock, guards, &c., are manufactured in the workshops attached to the Armoury.

The machines employed in the manufacture of the musket stocks are worthy of particular notice. By the kind courtesy of Colonel Ripley, facilities were afforded me for observing the time occupied in each operation.

The stocks are purchased rough from the saw for 28 cents (or 1*s.* 2*d.*) each.

	Time occupied.	
	Min.	Sec.
1. They are roughly turned in Blanchard's machine, which has been in operation nearly 30 years	4	11
2. While one stock is being turned, the attendant is able to face and slab another by a circular saw	3	30
3. The stock is next taken to what is called a "spotting" machine, where the sides are cut flat in different parts, to serve as bearings, or points to work from in future processes; this is done by 2 pairs of horizontal cutters, one pair at each end, and 3 single cutters in the centre	0	7
4. Next to a "barrel-bedding" machine, where a groove is cut for the barrel; this is done by 4 bits set with their guides in a row, in a sliding frame combined with a horizontal cutter, with a vibratory motion given by hand for shaping the groove conically, and a vertical bit for recessing	1	7½
The next operation, that of finishing the groove by chisel, is performed by hand in 1 min. 42 sec. .. 1 min. 42 sec.		
Carried Forward	8	55½

	Time occupied.	
	Min.	Sec.
Brought Forward	8	55½
5. The stock is then sawn to the required length	0	11½
6. A "bed" is next recessed for the side plate, the sides of the stock are flattened by 2 vertical cutters, and the bed is recessed by a horizontal bit	1	11¾
7. The edges of the stock are then faced by a horizontal cutter	0	14
8. The stock is next taken to a butt-plate machine, where a bed is recessed and screw-holes made for the butt-plate by a horizontal bit and screw, and also a vertical bit and screw	0	21½
9. Next to a "band-fitting" machine, where 3 horizontal cutters cut 3 straight bands, and a fourth bevils the upper or bayonet band	0	22¾
10. Next to a "band-finishing" machine, where 4 horizontal cutters round off the parts intervening between the bands	0	28½
11. The stock is then turned a second time, in order to smooth its surface, 1st from the butt to the breech tang	8	35
12. 2nd, from the breech tang to the end of the stock	5	28
13. It is next taken to the "lock-bedding" machine, where the bed for the lock is recessed and shaped by 5 vertical bits set with their guides in a circular frame, at equal distances from each other. The driving-strap is made to run on a loose pulley fixed above the circular frame, and as each bit is brought into operation the band drops from the loose pulley on the driving pulley of the bit which is brought underneath it, and is raised, when the operation is finished, to its former position, ready to descend on the pulley of the next bit. The cuttings are blown away by 2 fan-pipes	0	46¾
14. Next to the "guard-bedding" machine, it was similar in its construction to the former, but it carried 4 bits instead of 5, and recessed and shaped the bed for the guard	0	51
15. The holes for the side screws were then bored	0	15
then for the tang screw	0	8¾
16. The stock was lastly taken to the "band, spring, and ramrod-fitting" machine. A vertical revolving cutter grooved recesses for the band-springs, a horizontal cutter recessed the groove for the barrel	0	55¼
A hand operation then finished off the whole. Time, 35 seconds .. .. .. 35 sec.		
Total time of machine operations	28	45¼
Ditto hand ditto	2	17
	31	2¼
Allowance for double simultaneous operations during turning	8	58
Man's time given to the whole operations of making a complete musket-stock	22	4¼

The complete musket is made (by putting together the separate parts) in 3 minutes. All these parts are so exactly alike that any single part will, in its place, fit any musket.

The general principle adopted in the construction of these machines is that of guiding the cutter in its course, by a shaper or "former," that is, a pattern made exactly of the form in which it is required that the work should be shaped.

The number of muskets made in the year 1852, amounted to 19,800.

75. *Coast Survey Office, Washington.*—Workshops are attached to the Coast Survey Office, where copies of the standard weights and measures of the United States are made. The office supplies the capital of every State in the Union, in addition to the standard weights and measures, with three very accurate balances.

No. 1 is constructed to weigh from 50lbs. down to 10lbs.

No. 2 to weigh from 10lbs. to 1lb.

No. 3 to weigh from 1lb. to $\frac{1}{10,000}$ oz.

The estimated cost of the three is $4,600, about 900*l.* The latter balance was tested, and deflected by the $\frac{1}{10,000}$ oz. In weighing 1lb., the effect of the addition of $\frac{1}{200}$ grain was instantly visible.

When the balance is not in use, the beam is made to descend by means of a screw, so that two external cones, placed on its under side, rest in two internal cones fixed on the supporting frame. Two steel discs attached to the chains of the scales are, by the same screw, made to descend, and rest upon the frame. Thus the whole balance is supported, and there is no continued strain on the knife edges.

A lever worked by hand acts upon the two short vertical rods placed under the scales, and adjusts them evenly before commencing the operation of weighing.

The balance stands on four feet, each adjustable by screws.

The full set of standard weights and measures supplied by the office consists of—

1. A set of standard weights from 1lb. to 50lbs. avoirdupois; and 1lb. troy.
2. From 1oz. down to $\frac{1}{10{,}000}$ oz. troy.
3. A yard measure.
4. Liquid measures. The gallon and its parts down to half-pint inclusive.
5. A half-bushel measure.

Twenty-one States have been supplied, and other sets are being prepared for the remaining States. There are 13 workmen employed.

The United States standard yard has been obtained from a 7 feet standard procured from England.

It is made of gun-metal, about 2 inches broad and $\frac{3}{8}$ inch thick, and has a thin strip of silver, $\frac{1}{5}$ inch broad, let into it through its entire length. It is divided into small divisions, each being an aliquot part of an inch. The standard was obtained by taking the mean of a great number of measurements made from different points in the 7 feet scale.

A set of standards has been presented to France, and a set of French standards was presented to the United States in return.

It is a matter of surprise that while the people of the United States have long felt and appreciated the benefits of their decimal monetary system, the old English system of weights and measures has not yet been abolished by the Legislature. Its inconveniences are much complained of, and custom has tried to remedy its evident defects to a great extent by adopting the plan of reckoning by 100lbs. (instead of the cwt. or 112 lbs.) and by 1000lbs.

Monetary accounts are kept, and calculations are made with the greatest facility in dollars and cents, the dollar (4*s.* 2*d.*) being divided into 100 cents (a cent $\frac{1}{2}d$). Convenient coins called "dimes" are in circulation, 10 cents being equal to one dime, and 10 dimes making a dollar. Quarter dollar and half dollar pieces are also commonly used; there appears to be no reason why a decimal system would not afford equal advantages, if applied, as it doubtless will be eventually, to the scales of weights and measures.

The Coast Survey Office has custody of two instruments used in measuring by means of end measurements. A base line 7 miles long, was measured on an island near Charleston, in about six weeks. The measuring instruments were supported on two adjustable stands.

They were made on the compensating principle, and inclosed in a double case of tin, to prevent, as much as possible, their being affected by changes of temperature. The ends of the instruments were of agate, one flat, the other having a knife edge. The latter was made to slide, and was connected by a bell-crank lever to a spirit level, which indicated when the end measures were in contact, according to the method employed by Bessel, in making standard measures in Prussia.

CHAPTER XI.

ELECTRIC TELEGRAPHS.

76. The advantages to be derived from the adoption of the Electric Telegraph, have in no country been more promptly appreciated than in the United States. A system of communication that annihilates distance, was felt to be of vital importance, both politically and commercially, in a country so vast, and having a population so widely scattered. It met accordingly with great encouragement, both from the federal Government at Washington and from the local Governments of the various States.

Distances are now to be measured by intervals, not of space, but of time: to bring Boston, New York, and Philadelphia into instantaneous communication with New Orleans and St. Louis—to centralize in Washington, at any given moment, information gathered simultaneously from the far corners of the thirty-one provinces of the Union, is to extend throughout the confederacy bonds of the most intimate connexion.

In the operations of commerce, the great capitals of the North, South, and West are moved, as it were, by a common intelligence; information respecting the state of the various markets is readily obtained, the results of consignments may be calculated almost with certainty, and sudden fluctuations in price in a great measure provided against.

If, on the arrival of an European mail at one of the northern ports, the news from Europe report that the supply of cotton or of corn is inadequate to meet the existing demand, almost before the vessel can be moored intelligence is spread by the Electric Telegraph, and the merchants and shippers of New Orleans are busied in the preparation of freights, or the corn-factors of St. Louis and Chicago, in the far west, are emptying their granaries and forwarding their contents by rail or by canal to the Atlantic ports.

There may be, no doubt, similar general advantages derived everywhere from the introduction of the Electric Telegraph, but they are such as affect with peculiar benefit a country like the United States, consisting of confederated provinces, differing one from another in climate, in productions, in laws, and institutions, and in some cases in the character of their inhabitants.

77. The introduction of so important a system was not left to the unaided exertions of private enterprise. In 1844, Congress made a liberal grant in order to put in operation the first telegraph line that was erected in the States—that between Washington and Baltimore—and before seven years had elapsed the Committee on Post Offices and Post Roads presented to the Senate, in 1851, their report on the route which they had selected for a gigantic telegraph line, nearly 2,500 miles in length, connecting San Francisco with Natchez on the Mississippi, and thence with the vast network of lines that already covered the Atlantic States. Such was the rapid development of this system of communication, supported by the federal Government, and fostered by that of individual States, which passed general laws authorising the immediate construction of telegraph lines, wherever they would be conducive to the interest of the public, and affording every facility to the formation of companies for that purpose.

If a company, or even a private individual, should propose to construct a telegraph line, and can show that it would be beneficial to the public (and as to this proof there is generally but very little difficulty), he may obtain an Act authorising him to proceed, as a matter of course; no private interests can oppose the passage of the line through any property; there are no committees, no counsel, no long array of witnesses and expensive hearings; compensation is made simply for damage done, the amount being assessed by a jury, and generally on a most moderate estimate. With a celerity that is surprising a company is incorporated, the line is built, and operations are commenced. Similar facilities are also afforded in many of the States, by general laws authorising the construction of railroads.

78. There are in the United States between 20 and 30 joint-stock electric telegraph companies, and an endeavour is now being made to amalgamate them into one company. The systems generally in use are those of Morse, Bain, and House.

The conflicting claims of these three systems have formed the subject of protracted litigation, and, without going into minute details, it may be sufficient to mention the distinctive features of each.

Professor Morse employs receiving magnets which close local circuits attached to each telegraph office, and so charge another magnet called the register magnet; this acts upon an armature attached to a lever which presses down a metallic point upon a cylindrical roller, a strip of paper is passed at an uniform rate between the metal point and the roller, and by the indentation of lines and dots, representing letters of the alphabet, the message transmitted is registered at the rate of about 20 words per minute.

It has been also found practicable to receive and understand messages by merely listening to the click of the armature, and the attendant writes down the words of the message, trusting solely to his ear for interpreting them correctly.

The cost of a Morse Register is about $40, £8.

The system patented by Mr. Bain is called the Electro-chemical Telegraph.

He employs a metal disc, carrying a prepared sheet of paper, on which lines and dots are marked by the decomposition of a metallic point, acted upon by an electric current.

The metal disc revolves at an uniform rate by the agency of clock-work, and the point or pen is made to move over the paper laid on the disc in the direction of a spiral.

No receiving magnet is necessary, and a comparatively weak current of electricity, traversing long wires, leaves instantaneously a mark upon the prepared paper.

The system is capable of being so modified as to transmit messages with great rapidity. Spaces representing alphabetic lines and dots are punched out from a long strip of paper, called the message-strip; this is passed rapidly between a cylinder and a toothed lever connected respectively with the electrodes of a battery; when the tooth of the lever falls in the spaces punched in the strip, it will be in connection with the cylinder, and close the circuit; when the paper (which, being dry, is a non-conductor) intervenes, the circuit will be broken. When the circuit is closed, the pen fixed at the other end of the wire will mark on the paper lines and dots exactly corresponding to those punched out of the message-strip.

In Mr. House's system the message is printed by the telegraph instrument itself. The electric current is made to act by rapid pulsations on an "axial magnet" that opens and closes a valve connected with a pneumatic printing-machine.

The machine, which is ably contrived, is worked by manual power, and prints messages at the rate of about 20 words per minute; its cost is about $250 (£50).

Grove's batteries are generally used in all the systems.

79. The aggregate length of the telegraph lines in the United States exceeded, in 1852, 15,000 miles, of which—

12,124 were worked on the system of Morse.
1,199 . . . Bain.
1,358 . . . House.

These numbers have been considerably increased this year, and many amalgamations of the different companies working under Morse's and Bain's patents have been made.

In November, 1852, eleven different companies had offices in New York.

Extracts from the annual reports of two companies, one whose line extends from New York to Washington, in competition with a rival line; the other a western company, whose line connects Pittsburgh with Louisville, will serve to give an idea of the amount of business carried on.

80. *New York and Washington Line.*—Messages are charged at the rate of 50 cents (2*s.* 1*d.*) for 10 words, and 5 cents (2½*d.*) for every additional word, or transmission from New York to Washington, a distance of 270 miles.

In the month of		Messages.		Receipts.
July, 1851,	there were sent	13,463,	producing	$4,991 62, about £1,000
January, 1852,	,,	23,962,	,,	$11,352 97, about £2,230
June, 1852,	,,	25,298,	,,	$11,832 03, about £2,360
Total for year ending June, 1852		253,857	,,	$103,232 37, about £20,000

The capital of the company is $370,000 (about £70,000); it has 7 wires from New York to Philadelphia, 6 from Philadelphia to Washington, connecting together 13 stations.

The number of persons employed on this line, including the staff of clerks and out-door surveyors and messengers, amounts to 125.

It should, however, be borne in mind that the distances through which messages have to be transmitted in America are so great that a slight delay in time is not of that immediate importance which it is in our own country; especially when it is considered that in England the great proportion of business is crowded into the "office hours" of the day, while in America it is spread over the entire 24 hours.

The average cost of constructing the line is estimated at $185 per mile.

7. *Pittsburgh and Louisville Telegraph Line :—*

Length of line, 450 miles.
Words transmitted in 1850, 3,602,760.

Total receipts	..	$73,278, about £14,500.

81. The most distant points connected by electric telegraph in North America are Quebec and New Orleans, which are 3,000 miles apart, and the network of lines extends to the west as far as Missouri, about 500 towns and villages being provided with stations.

There are two separate lines connecting New York with New Orleans, one running along the sea-board, the other by way of the Mississipi, each about 2,000 miles long. Messages have been transmitted from New York to New Orleans, and answers received, in the space of three hours, though they had necessarily to be written several times in the course of transmission.

When the contemplated lines connecting California with the Atlantic, and Newfoundland with the main continent, are completed, San Francisco will be in communication with St. John's, Newfoundland, which is distant from Galway but five days' passage. It is, therefore, estimated that intelligence may be conveyed from the Pacific to Europe, and *vice versa,* in about six days.

82. The cost of erecting telegraph lines varies according to localities, but the expenses upon the whole are estimated to average about $180 (about £35) per mile throughout the States; the moderate amount of this estimate is, in a great measure, to be attributed to the facilities afforded by the general telegraph laws for the formation of companies and the construction of lines.

The electric telegraph is used by all classes of society as an ordinary method of transmitting intelligence.

Government despatches and messages, involving the life or death of any persons, are entitled to precedence, next come important press communications, but the latter, if not of extraordinary interest, await their regular turn.

The leading newspapers of New York contribute jointly towards the expenses of daily telegraphic communications. The annual sum paid by the "Associated Press" averages $30,000 per annum.

The following is the tariff for the press despatches:—

	Under		200	miles,	1	cent per	word.
Between	200	and	500	,,	2	,,	,,
,,	500	,,	700	,,	3	,,	,,
,,	700	,,	1,000	,,	4	,,	,,
,,	1,000	,,	1,500	,,	5	,,	,,
,,	1,500	,,	over	,,	6	,,	,,

Assuming 3 cents as the mean average, the total amount of matter received by telegraph for the "New York Associated Press" amounts to a million words per annum, or about 600 columns of a London newspaper of the largest size, averaging about two columns per day.

Supposing six papers to be associated together, the share of each would annually amount to about $5,000, or £1,000, for two columns of telegraphic intelligence daily.

Commercial men use the electric telegraph in their transactions to a very great extent. In 1852 there were transmitted by one of the three telegraph lines that connect New York and Boston between 500 and 600 messages daily. The sums paid on this line by some of the principal commercial houses who used it averaged in 1852 for each from $60 (£12) to $80 (about £16) per month.

On other lines the leading commercial houses were estimated to pay from $500 to $1,000 (£100 to £200) per annum for telegraphic despatches.

83. Interruptions occur most frequently from the interference of atmospheric electricity; in summer they are estimated to take place on an average twice a week, but many contrivances have been adopted for obviating this inconvenience, such as lightning arrestors, &c., which are generally known; the number of interruptions have been thereby reduced about 30 per cent.

Other accidental causes of interruption occur irregularly from the falling of the poles, the breaking of the wires by falling trees, and, particularly in winter, from the accumulated weight of snow or ice.

The electric current is made to act through long distances, by using local and branch circuits, and relay magnets, in those systems where it would be otherwise too weak to operate effectually.

In Mr. Bain's system, a weak current is found sufficient for very long distances; between New York and Boston, a distance of 270 miles, no branch or local circuit is required. In some cases, where both Morse's and Bain's telegraphs are used by an amalgamated company in the same office, it is found convenient, in certain conditions of the atmosphere, to remove the wires from Morse's instruments, and connect them with Bain's, on which it is practicable to operate when communication by Morse's system is interrupted.

It is generally believed that by laying insulated wires underground the interruptions will be reduced so as to be altogether inconsiderable. The expense of the process, however, is regarded as a great impediment in the United States, where cheapness of construction is an object of the highest consideration.

84. The application of the electric telegraph is not confined to the transmission of messages from one part of the States to another: in the form of a local or municipal telegraph, it is employed as an important instrument of regulation and intelligence in the internal administration of towns.

No adaptation of the system can be more interesting and useful than that which is made for the purpose of conveying signals of alarm and intelligence in the case of fire.

This system has been very completely developed in Boston.

The city is divided into seven districts, each provided with a powerful alarm bell. Every district contains several stations, varying in number according to its size and population. There are altogether in the seven districts 42 stations. All these stations are connected with a chief central office, to which intelligence of fire is conveyed, and from which the alarm is given; two telegraph wires are employed, a return wire being used to complete the circuit, and provide as completely as possible against accidental interruption or confusion.

At each of the 42 stations, which are placed at intervals of 100 rods throughout the city, there is erected in some conspicuous position a cast-iron box containing the apparatus for conveying intelligence to the central office. The box is kept locked, but the key is always to be found in the custody of some person in the neighbourhood, whose address is painted on the box door.

On opening this door, access is gained to a handle which is directed, by a notice painted above it, to be turned slowly several times. The handle turns a wheel that carries a certain number of teeth, arranged in two groups, the number of teeth in one representing the district, in the other, the station; these teeth act upon a signal key, closing and breaking the circuit connected with the central office as many times as there are teeth in the wheel. Signals are thus conveyed to the central office, and, by striking the signal bell a certain number of times, the district and station from which the signal is made is indicated.

An attendant is always on the watch at the central office, and on his attention being called to the signals by the striking of a large call bell, he immediately sets in motion his alarm apparatus, and by depressing his telegraph-key, causes all the alarm bells of the seven districts to toll as many times in quick succession as will indicate the district where the fire has occurred, the alarm being repeated at short intervals for as long a time as may be necessary.

The signal-boxes erected at the stations contain, in addition to the signal-handle, a small electro-magnet, an armature, and a signal-key, so that full and particular communications can be made between each box and the central station, the clicks of the armature forming audible signals. They have also an apparatus called a "Discharger of Atmospheric Electricity," for preventing the occurrence of injuries during thunderstorms.

By this system certain information is given to the central office at the earliest possible moment of the exact locality in which a fire may have broken out, and the alarm is immediately spread over the entire city.

Every one who is aroused by the alarm is enabled to tell at once whether interest or duty calls him to the scene of action, and the exact point to which assistance is summoned. Should the alarm be given in the night, those whose attention is awakened may ascertain from the tolling of the bell the precise quarter in which danger threatens, and should they have been needlessly disturbed, may rest in peace, and find in the knowledge that they and theirs at least are in safety, a consolation for broken slumbers.

85 Telegraph wires in towns are almost universally carried along the tops of houses, or on poles erected in the streets, instead of being conveyed in pipes underground. So little difficulty is met with on the part of proprietors of houses, that telegraph lines are in some cases erected by private individuals for their own particular use. As an instance, may be mentioned the case of a large manufacturer in New York, who has an office in one part of the city, while his works lie in a contrary direction. In order to keep up a direct communication between both, he has erected a telegraphic wire at his own expense, and carried it over the tops of the houses intervening between his office and his works, having obtained without any trouble the permission of their various owners.

86. It has been already stated that the number of miles of telegraph lines erected in the United States exceeded, in 1852, 15,000; and it may be useful, in conclusion, to give a list of them, and the number of wires they had each in operation.

MORSE LINES.	No. of Wires.	Length in Miles.
1. New York to Boston, *viâ* Springfield	3	250
2. New York to Buffalo, *viâ* Troy	3	513
3. New York to Dundirk	1	440
4. New York and Erie Railroad Telegraph	1	460
5. New York to Washington, *viâ* Baltimore	7	260
6. New York to New Orleans (sea-board)	1	1,966
7. Boston to Portland, *viâ* Dover	2	100
8. Philadelphia to Lewiston, Del.	1	12
9. Philadelphia to Pittsburgh, *viâ* Harrisburg ..	1	309
10. Philadelphia to Pottsville, *viâ* Reading	1	98
Carried over ..	21	4,408

		No. of Wires.	Length in Miles.
	Brought forward	21	4,408
11.	Baltimore, *viâ* Wheeling, to Cumberland	1	324
12.	Baltimore to Harrisburg, *viâ* York, Pa.	1	72
13.	Washington to New Orleans, *viâ* Richmond, Pa.	1	1,716
14.	Harpers Ferry to Winchester, Pa.	1	32
15.	York to Lancaster, *viâ* Columbia, Pa.	1	22
16.	Reading to Harrisburg	1	51
17.	Pittsburg to Cincinnati, *viâ* Columbia	1	310
18.	Cincinnati to St. Louis, *viâ* Vincennes	1	410
19.	Cincinnati to Maysville, Ky., *viâ* Ripley	1	60
20.	Columbia to New Orleans, *viâ* Natchez	1	638
21.	Cincinnati to St. Louis, *viâ* Indianopolis	1	400
22.	Cincinnati to Sandusky	1	218
23.	Cincinnati to Dayton and Chicago (Ohio wire)	1	100
24.	St. Louis to Chicago, *viâ* Alton, I. M.	1	330
25.	St. Louis to Independence, Mobile	1	25
26.	Alton to Galena, *viâ* Quincey	1	380
27.	New Orleans to Balize	1	90
28.	Cleveland to Cincinnati	2	125
29.	Cleveland to Pittsburgh	1	150
30.	Cleveland to Zanesville	1	150
31.	Zanesville to Newark	1	40
32.	Toledo to Terra Haute, *viâ* Fort Mayne	1	300
33.	Sandusky to Mansfield	1	40
34.	Columbus to Portsmouth, O.	1	90
35.	Columbus to Lancaster, O.	1	25
36.	Lancaster to Logans Port	1	15
37.	Milwaukie to Green Bay	1	200
38.	Milwaukie to Galena, *viâ* Madesa	1	250
39.	Banesville to Marietta	1	66
40.	Buffalo to Milwaukie, *viâ* Cleveland and Chicago	2	400
41.	Buffalo to Queenston, Canada, *viâ* Lockport	1	48
42.	Buffalo to Detroit, *viâ* Cleveland	1	400
43.	Syracuse to Oswego, N. Y.	1	40
44.	Troy to Montreal, *viâ* Burlington	1	278
45.	Portland to Calais (Maine)	1	350
46.	Calais to Halifax, *viâ* St. John's	1	400
47.	Worcester to New Bedford, *viâ* Providence	1	97
48.	Worcester to New London, *viâ* Norwich	1	74
	Total	61	13,124

Bain Lines (some of these are now amalgamated with the Morse Lines).

		No. of Wires.	Length in Miles.
1.	New York to Boston (Merchants)	2	250
2.	New York to Buffalo	2	513
3.	Boston to Portland	1	100
4.	Boston, *viâ* Burlington, to Ogdensburgh	1	350
5.	Troy to Saratoga	1	36
	Total	7	1,249

House Lines, belonging to one Company.	No. of Wires.	Length in Miles.
1. New York to Washington	2	260
2. New York to Boston	2	250
3. New York to Buffalo	3	513
4. Buffalo to Cincinnati	1	325
Total	7	1,348

These lines are being rapidly extended. It is intended to connect Cincinnati with Louisville and St. Louis.

CANADIAN LINES.

1. Quebec to Suspension Bridge, Niagara		155
2. Quebec to New Brunswick Frontier		220
3. Montreal to No. 7 State Line, Highgate		47
4. Montreal to Bytown		115
5. Hamilton to Port Sarina, on L. Huron		143
6. Niagara to Chippewa		14
7. Brantford to Simcoe		33
8. Kingston to Hamilton		256
Canadian Lines		983
Morse do.		13,124
Bain do.		1,249
House do.		1,348
Total Lines in North America		16,704

CHAPTER XII.

THE PATENT SYSTEM.

87. The patent system of the United States is based upon the first Article of the Constitution, which says:—

"The Congress shall have power to promote the progress of science and the useful arts by securing, for limited times, to authors and inventors the exclusive right to their respective writings and discoveries."

Letters patent, securing this exclusive right, and extending to all the States of the Union, are granted by the federal Government. The Patent Office, from which they issue, is attached to the department of State, and its chief officer, "called the Commissioner of Patents, is appointed by the President, by and with the advice of the Senate."

All patents are issued in the name of the United States, signed by the Secretary of State, and countersigned by the Commissioner of Patents.

"All actions or suits, arising under any law granting or confirming to inventors the exclusive right to their inventions or discoveries, are originally cognizable by the Circuit Courts, and an appeal lies to the Supreme Court of the United States."

The Patent Office is conspicuous among the public buildings of Washington for the beauty of its architecture; it is built of white marble, and modelled after the Parthenon at Athens. When completed, it will be quadrangular, having a frontage of 413 feet, with a depth of 280 feet, and inclosing an open court, having an area of 270 feet by 112 feet. The principal entrance leads into a hall, round which are ranged glazed cases, containing models of inventions. From the right of the hall branches off a passage, on each side of which lie the various offices of the commissioner, examiners, and clerks, and the library. On the left are three large rooms, appropriated to the reception of models of all the inventions patented in the United States. At the extreme end of the hall is a double staircase leading to the superior apartments, one of which is used as a museum.

The various departments have each their respective offices; in some the applications for letters patent are received, in others the alleged inventions are examined (each examiner taking some particular subject), in others the drawings and specifications are preserved in portfolios, which slide on rollers in deep cases. There is also an extensive library, to which large additions are being continually made, for official use, and the convenience of applicants for patents.

The model-rooms contain upwards of 23,000 models, arranged in large glass cases, but there is no catalogue to assist or guide those who search for any particular model that may be required for inspection.

It not unfrequently happens that the subject of a patent undergoes considerable modification in the case of "additional improvements" being added, or when the letters-patent are "re-issued," so that the model in such a case does not eventually represent the invention for which the patent is virtually granted, and is therefore useless. If, however, the models were to be so classified that those which are valuable were separated from those which are worthless, and arranged in appropriate and distinctive series, they would then exhibit, step by step, the progress which had been made in the particular art or manufacture to which they belong, and with the aid of a well-digested catalogue they would be of great national utility. But an assemblage which comprehends indiscriminately models of every patented invention must, sooner or later, become so large that confusion only can result, and all practical purposes of utility must be defeated.

The models of the inventions for which patents have been refused are kept in the basement vaults, and it is doubtful if they serve any purpose sufficiently useful to repay the trouble of preserving them.

88. The Official Staff of the Patent Office is at present composed of—

The Commissioner,	receiving	$3,000	per annum.
The Chief Clerk	,, ...	2,000	,,
Six Examiners	,, ...	2,500	,,
One Assistant, Class IV.	,, ...	1,800	,,
Twelve do., Class III.	,, ...	1,500	,,
Seven do., Class II.	,, ...	1,200	,,
Librarian	,, ...	1,200	,,
Machinist	,, ...	1,250	,,
Agricultural Clerk	,, ...	1,500	,,

Twenty temporary Clerks at a variable salary.

The total amount of official salaries was, in 1852, $56,064 (about £11,200).

The amount of business transacted in the office in 1852 will appear from the following statement:—

Applications for patents pending January 1852 ..	155
Applications received during 1852	2,639
Patents issued	1,020
Rejections and suspensions	1,293
Applications undecided	481

Among the patents issued are reckoned—

Re-issues	18
Additional improvements	4
Extensions	3
Designs	107

There were also filed—

Caveats	996
Disclaimers	2
Patents expired	525

In order to convey a general idea of the different classes of invention for which the patents were granted, and the number in each class during the year 1852, they will be given in the classified form adopted in the Patent Office.

Class	1.	Agricultural implements	114
,,	2.	Metallurgy manufacture of metals, and instruments therefor	125
,,	3.	Textile manufactures and machines for preparing fibrous substances	69
,,	4.	Chemical process manufactures and compounds, including medicines, dyeing, colour-making, distilling, soap and candle-making, mortars, cements, &c.	50
,,	5.	Calorifics, comprising lamps, fireplaces, furnaces, stoves, preparations of fuel, &c.	50
,,	6.	Steam and gas-engines, boilers and furnaces	36
,,	7.	Navigation and maritime implements, vessels, diving apparatus, life-preservers, &c.	23
,,	8.	Mathematical, philosophical, and optical instruments, clocks, &c	27
,,	9.	Civil engineering and architecture, and apparatus employed on railroads, bridges, waterworks, &c.	32
,,	10.	Land conveyances, roads, vehicles, wheels, &c.	72
,,	11.	Hydraulics and pneumatics, water-wheels, windmills, apparatus for raising or delivering fluids	16
,,	12.	Lever screw, and mechanical power applied to pressing, weighing, raising and moving weights	12
,,	13.	Grinding-mills, gearing, grain-mills, and mechanical movements and horse powers	41
,,	14.	Lumber-machines for dressing wood	44
,,	15.	Stone and clay manufactures, pottery, glass, bricks, stone-dressing, cements, &c.	29
,,	16.	Leather-dressing and manufactures, boots, harness, &c.	26
,,	17.	Household furniture, domestic implements, feather-dressing mattresses	43
,,	18.	Fine arts, music, painting, sculpture, engraving, books, paper, printing, binding, jewellery	48
,,	19.	Fire-arms, implements, and munitions of war	7
,,	20.	Surgical and medical instruments, trusses, bathing apparatus, &c.	13
,,	21.	Wearing apparel, toilet articles, and instruments for manufacturing them	16
,,	22.	Miscellaneous	20
			913
		Designs, &c.	107
		Patents issued	1,020

89. *Persons entitled to Apply for Letters Patent.*—An original inventor only is entitled to apply for a patent; the mere introducer of an invention has no claim whatever.

Every applicant is required to make oath "that he verily believes himself to be the true and first inventor," and whenever it appears that the inventor did so believe at the time of his application, the subsequent discovery that the invention had been used abroad will not invalidate his patent, provided it does not appear that the invention had been patented, or described in a printed publication.

If the inventor shall have assigned his entire interest previous to the application, and the assignment has been recorded in the Patent Office according to law, the patent will be issued to the assignee, but the inventor must still sign the application.

Upon the decease of an inventor, his legal representatives may (on the same conditions on which the inventor, if living, would stand) obtain a patent for the benefit of his heirs or devisees, even though the inventor had not during his lifetime taken any steps towards securing a grant.

Foreigners who have resided for one year previous to their application, and have made oath of their intention to become naturalised, have all the privileges of citizens.

90. *Subject-matter of Letters Patent.*—It has been said that a patent is only granted for a *bonâ fide* invention, and not for a mere introduction.

In other respects there is not much difference between the law of England and that of the United States.

It should be remarked, however, that all applications for grants are rejected in which the examiners of the Patent Office believe that they can discover any "double use," that is, an application of an old contrivance to a new purpose: so rigidly is this rule followed out, that in some instances patents have been refused for inventions confessedly valuable, and producing new manufactures, because in totally different branches of manufacture inventions somewhat similar had been already patented.

The law of the United States holds as good subject-matter for a grant:—

"Any new or useful art, machine, manufacture or composition of matter, or any new and useful improvement on any art, machine, manufacture, or composition of matter."

With regard to prior use, an inventor has very extensive privileges in the United States.

He may, during the period of two years, publicly use, and even sell his invention, without invalidating a patent obtained at the end of that time; but a public use for a longer time is considered as an abandonment of his discovery to the public.

A prior discovery will not invalidate a subsequent patent if it can be shown that it was laid aside without being perfected or reduced to practice.

A discovery that has once been abandoned to the public, by being used, unprotected, for more than two years, or otherwise, cannot be subsequently reclaimed.

A patent will be granted for an invention patented in a foreign country at any time within six months of the date of the foreign patent, or afterwards if it can be shown that the foreign invention has not been brought into public use in the United States.

91. *Caveats.*—A citizen or alien of one year's residence, intending to become naturalised, who wishes for time to perfect his invention, may file a caveat in the Patent Office, which, for the space of one year, will prevent any applicant from obtaining a patent for an invention of a similar character, without notice being given to the caveator.

This notice requires him to complete his application within three months, and if the two applicants appear to make similar claims, the commissioner will appoint a day for hearing both parties, that is, will "grant an interference," and will direct a patent to issue to him who shall prove to be the original inventor.

A caveat may be renewed from year to year during the time that an applicant is perfecting his invention.

A foreigner cannot file a caveat.

The fee for a caveat is $15 (£3).

92. On making applications for letters patent, there are six requisites to which attention must be paid:—

1st. The petition addressed to the commissioner of patents.
2nd. The specification.
3rd. The oath of originality.
4th. Drawings.
5th. Model, or specimens of the invention.
6th. Proper fees.

The petition for a grant must be addressed to the commissioner of patents, and state that the requirements of the Act have been complied with. It must be signed by the inventor, or if he be dead, by his legal representatives.

93. *The Specification.*—The specification differs but little in its character from an English specification.

It must be "a written description of the invention, and the manner of using it, expressed in such full and clear terms as to enable a skilled person to use the same; and, in the case of a machine, must particularly specify and point out the part, combination, or improvement, claimed as an invention."

It is not, however, construed with the same rigid severity as an English specification,

For the Act, March 3, 1837, s. 9, enacts that "Whenever by mistake, accident, or inadvertence, and without any wilful default, or intent to defraud or mislead the public, any patentee shall have in his specification claimed to be the original and first inventor or discoverer of any material, or substantial part of the thing patented, of which he was not the first and original inventor, and shall have no legal and just right to claim the same, in every such case the patent shall be deemed good and valid for so much of the invention and discovery as shall be truly and *bonâ fide* his own." But it must in such a case be shown that the part really invented is a substantial part.

Power is also given to the patentee in such a case to bring an action for infringement; but if he obtain a verdict on the question of infringement, he is not entitled to costs unless he has filed a disclaimer "prior to the commencement of the suit," which may happen to be subsequent to the act of infringement.

There is a further provision "that no person be entitled to the benefits of this enactment who shall have unreasonably neglected or delayed to enter at the Patent Office a disclaimer."

The specification is drawn up and filed *before* the grant of the patent to which a copy is annexed—the two being construed together as one document.

The patent may be dated from the time of filing the specification and drawing, if it be more than six months previous to the actual issue.

94. The oath or affirmation is a statement annexed to the specification, signed by a person lawfully qualified to administer an oath, certifying that the applicant had made oath in proper form that he believed himself to be the original inventor of what he claimed, and that he did not know or believe that the same was ever before known or used. If he be a resident alien, intending to become a citizen, that circumstance also must be stated on oath.

95. Drawings, models, and specimens are always absolutely requisite whenever the case admits of their being supplied.

96. The fees payable are as follow :—

If the application be made by a citizen, or foreigner who has resided for one year previous to his application, and made oath of his intention to become a citizen, the fee is - - - - - $30 (£6)

If a subject of Great Britain -	$500 (£105)
If any other foreigner - -	$300 (£63)

The principle on which this scale appears to have been drawn up will be alluded to hereafter.

When these six requisites have been furnished, the application is taken up in its turn, unless the commissioner should otherwise decide for convenience of classification, or unless the applicant has already taken out a foreign patent. For, since an American patent can only run for fourteen years from the date of a foreign patent, the applicant would suffer by delay.

97. The examination of the documents furnished to the Patent Office with the application is very strict, and the claims in respect of novelty undergo long consideration; all claims savouring of a "double use" being, as was before stated, rejected.

If the drawings or specification are found defective, they are returned to the applicant with instructions how to alter them.

If it be deemed advisable to prepare new papers, the originals must be returned, and if the character of the invention is materially changed after the application is filed, it must be withdrawn altogether, and a new one filed, two-thirds of the former fees being allowed.

If, on examination, the claims are found to embrace what, in the judgment of the examiners, is considered to be old, the application is at once rejected, and notice is given to the applicant, with a full statement of the grounds of the rejection, and reference to prior inventions which he may examine in the office.

He has also the opportunity of explaining his claims to the examiner in a private interview.

If, in the end, he is dissatisfied with the decision of the Commissioner of Patents, he may appeal to the District Judge of Columbia, on paying $25 (£5), and a still further appeal may be made by bill to a court of equity.

When, on an examination of an application, it is found that a caveat has been entered for a similar invention within the previous year, notice is given to the caveator to complete his application within three months; and if, on its coming in, the claims are found to be conflicting, an "interference" is granted.

When an applicant claims anything embraced in an unexpired patent, and persists in his claims to priority, the commissioner will, at his request, "grant an interference" between him and the patentee.

The Office has, however, no power over the patent, even though it decide in favour of the other party, and grant him also a patent for his claim.

The unsuccessful party is allowed an appeal to the District Judge of Columbia.

98. If additional improvements be made to an invention subsequent to the date of a patent, they may be added to the specification, and incorporated with the original patent: fee, $15 (£3).

The object of this provision appears to be to save an inventor the extra expense and trouble of taking out a new patent, comprising his recent inventions, and founded on his original claims.

The incorporation of new claims in a patent bearing an antecedent date, seems open to great objection.

99. *Re-issue.*—The specification and claims of a patent undergo considerable modification in the case of a re-issue, and the provision is one liable to entail great abuses.

Section 13 of the Act of 4th July, 1836, enacts that when a patent is inoperative, or invalid by reason of a defective or insufficient description or specification, if the error arise from inadvertency, accident, or mistake, and without any fraudulent or deceptive intention, the commissioner may, on the surrender of the old defective patent, "cause a new patent to be issued for the same invention, and for the residue of the period then unexpired for which the original patent was granted, in accordance with the patentee's corrected description and specification; and the patent so re-issued, together with the corrected descriptions and specifications, shall have the same effect and operation in law, on the trial of all actions hereafter commenced, for causes subsequently accruing, as though the same had been originally filed in such corrected form, before the issuing of the original patent." The fee for a re-issue is $15 (£3).

But if it be found that the specification comprises several distinct substantive inventions, a patent is issued for each, and the fee for each is $30 (about £6).

It is obvious that there is scarcely any limit to the permutations and combinations which may be made out of the claims of a long, complicated, and ambiguous specification.

Modern improvements are seldom or never so new in character and form as to be entirely dissimilar to every previously patented invention.

It frequently happens that there exist a variety of patents whose claims are similar in character, and which are all worthless from the lack of something which is hit upon by a subsequent discoverer, who supplies the one thing needful to success.

It may be conceived with what eagerness antedated patents would in such a case be "surrendered"—with what ingenuity their claims would be strained and distorted so as to embrace the identical one thing, and embody it in a "re-issued" patent, bearing the same date as the old one, and thus rob the really meritorious inventor of the fruits of his labours.

100. *Extension of the term of a Patent.*—The commissioner has power to grant an extension of a patent for seven years, if it shall be shown that the invention is in itself "novel, useful, and important to the public, and that the inventor has not been adequately remunerated, though he used due diligence in introducing his invention into general use."

The extension cannot be granted after the patent expires, so the application must be made a sufficient time before its expiration, to allow of a hearing and a decision, and yet not so long as to render the general statement of profits and expenses materially inaccurate.

101. *Assignment.*—An invention may be assigned by an instrument in writing, either partially or entirely, before or after a patent is obtained.

If the assignment be of the entire interest, and precede the grant of the patent, it must be recorded in the Patent Office, and then the patent issues to the assignee. If the assignment be of the entire interest, and be made after the grant, it must be recorded within three months at the Patent Office to hold good against a subsequent purchaser without notice.

102. *Refusal of Letters Patent.*—When an application for a patent is refused or withdrawn, two-thirds of the fees paid are returned, unless a caveat fee had been reckoned in the amount.

The money is paid in specie at the Patent Office, or is forwarded by mail to the applicant, or paid to his order.

103. *Designs.*—A patent for a design is granted only to citizens, or aliens who have resided for one year in the United States, and made oath of their intention to become citizens.

The fees payable are only one-half what are paid for a patent for an art or manufacture, and the term of the grant extends only to seven years.

All other regulations and provisions are the same as in the case of ordinary patents.

104. All applicants for letters patent have direct access to the examiners, and are frequently heard again and again while they explain the principles of their discoveries in personal interviews. Their applications, when defective, are returned, the defects pointed out, and also the best method of correcting them; sometimes an application is returned for correction as many as six times.

The principle of affording an applicant direct access to the Patent Office has many advantages; but it is doubtful if the long and laborious investigation which an application receives is ultimately beneficial. It seems impossible that such investigations can ever be complete and satisfactory, however great may be the skill of the examiners, however wide and extended their knowledge of arts, sciences, and manufactures.

The accumulations of business are necessarily very great, in spite of the most assiduous attention of the examiners to their duties, and the system which is adopted of assigning to each a separate department; a period of five or six months usually, and in some cases a much longer time, elapses before an application can be decided upon, a delay which is often attended with great inconvenience.

It may be doubted whether too much is not attempted by the examiners in undertaking to decide the important questions of novelty and utility, either in the case of applications allowed or rejected; and whether any such preliminary inquiries ought not to be limited to warning an applicant of what has been done or known before, and referring him to authentic sources of information, but allowing him upon such warning to take out letters patent at his own risk.

In such a case the patent might safely be left to find its proper position and value when brought before the public, and there would be ample opportunity of testing its validity and utility both by public opinion and, if requisite, ultimately in a court of law.

The policy of requiring models of inventions in every case where they can be supplied, and forming them into one vast indiscriminate collection, has been already discussed.

The abuses arising from the system of extending and altering the claims of a specification in the case of re-issues, have also been noticed.

105. *Repeal of Letters Patent.*—It appears to be a subject of much complaint, that there exist no means of repealing or quashing an invalid patent by legal proceedings, similar to those provided for by an English writ of *scire facias.* It may be true that an invalid patent is naturally disregarded by the public, but it is still a weapon of legal offence and annoyance which it would be as well to put aside altogether.

106. It remains to say a few words, in conclusion, on the scale of fees.

These are extremely moderate in the case of citizens, and the privileges and protection afforded by letters patent are most properly placed within the reach of all citizen inventors.

But foreigners labour under great disadvantages, being required, if British subjects, to pay nearly seventeen times as much as a citizen ($500), if any other foreigner, ten times as much as a citizen ($300).

The principle of retaliation, which alone can be alleged as a reason for drawing up a scale of fees so disadvantageous to foreigners, seems wanting in fairness, at least in the case to which it was most pointedly directed. For a citizen of the United States, on applying for letters patent in England, stands, and always has stood, on terms of perfect equality with British subjects.

The following is the scale of fees payable in connection with the grant of letters patent in the United States:—

On application for a design	$15	(about £3)
„ „ caveat	20	(„ 4)
„ „ patent in the case of a citizen or resident foreigner intending to become naturalised	30	(„ 6)
„ „ in the case of a British subject	500	(„ 105)
„ „ „ any other foreigner	300	(„ 63)
„ „ Disclaimer	10	(„ 2)
Addition of improvements	15	(„ 3)
Re-issue	15	(„ 3)
Extension of term	40	(„ 8)
Appeal	25	(„ 5)

Copies of letters patent are furnished by the Office on payment of ten cents (*5d.*) for every 100 words, and the cost of copying the drawings.

The charge for recording an assignment is for—

300 words and under	$1	0
Over 300 and not over 1,000 words	2	0
Over 1,000 words	3	0

CONCLUSIONS.

The parts of the United States which I visited form, geographically, a small portion of their extended territory, but they are the principal seats of manufactures, and afford ample opportunities for arriving at general conclusions.

I could not fail to be impressed, from all that I saw there, with the extraordinary energy of the people, and their peculiar aptitude in availing themselves to the utmost of the immense natural resources of the country.

The details which I have collected in this report show, by numerous examples, that they leave no means untried to effect what they think it is possible to accomplish, and they have been signally successful in combining large practical results with great economy in the methods by which these results are secured.

The labouring classes are comparatively few in number, but this is counter-balanced by, and indeed may be regarded as one of the chief causes of, the eagerness with which they call in the aid of machinery in almost every department of industry. Wherever it can be introduced as a substitute for manual labour, it is universally and willingly resorted to; of this the facts stated in my report contain many conclusive proofs, but I may here specially refer, as examples, to plough making, where eight men are able to finish thirty per day; to door making, where twenty men make 100 pannelled doors per day; to last making, the process of which is completed in 1½ minutes; to sewing by machinery, where one woman does the work of 20; to net making, where one woman does the work of 100. It is this condition of the labour market, and this eager resort to machinery wherever it can be applied, to which, under the guidance of superior education and intelligence, the remarkable prosperity of the United States is mainly due. That prosperity is frequently attributed to the possession of a soil of great natural fertility, and it is doubtless true that in certain districts the alluvial deposits are rich and the land fruitful to an extraordinary degree; but while traversing many hundred miles of country in the Northern States, I was impressed with the conviction that the general character of the soil there was the reverse of fertile.

It is not for a moment denied that the natural resources of the United States are immense, that the products of the soil seem capable of being multiplied and varied to almost any extent, and that the supplies of minerals appear to be nearly unlimited.

The material welfare of the country, however, is largely dependent upon the means adopted for turning its natural resources to the best account, at the same time that the calls made upon human labour are reduced as far as practicable.

The attention paid to the working of wood, some details connected with which I have included in the report, is a striking illustration of this. The early settlers found in the forests which they had to clear an unlimited supply of material, which necessity compelled them to employ in every possible way, in the construction of their houses, their furniture, and domestic utensils, in their implements of labour, and in their log-paved roads.

Wood thus became with them a universal material, and work-people being scarce, machinery was introduced as far as possible to supply the want of hands. The character thus given to one branch of manufactures has gradually extended to others. Applied to stone-dressing, for example, one man is enabled, as I have shown, to perform as much work as twenty masons by hand. So great again are the improvements effected in spinning machinery, that one man can attend to a mule containing 1,088 spindles, each spinning 3 hanks, or 3,264 hanks in the aggregate per day. In Hindoostan, where they still spin by hand, it would be extravagant to expect a spinner to accomplish one hank per day; so that in the United States we find the same amount of manual labour, by improved machinery, doing more than 3,000 times the work. But a still more striking comparison between hand and machine labour may be made in the case of lace making in England. Lace of an ordinary figured pattern used to be made "on the cushion" by hand, at the rate of about three meshes per minute. At Nottingham, a machine attended by one person will now produce lace of a similar kind at the rate of about 24,000 meshes per minute; so that one person can, by the employment of a machine, produce 8,000 times as much work as one lace maker by hand.

The results which have been obtained in the United States, by the application of machinery wherever it has been practicable to manufactures, are rendered still more remarkable by the fact, that combinations to resist its introduction there are unheard of. The workmen hail with satisfaction all mechanical improvements, the importance and value of which, as releasing them from the drudgery of unskilled labour, they are enabled by education to understand and appreciate. With the comparatively superabundant supply of hands in this country, and therefore a proportionate difficulty in obtaining remunerative employment, the working classes have less sympathy with the progress of invention. Their condition is a less favourable one than that of their

American brethren for forming a just and unprejudiced estimate of the influence which the introduction of machinery is calculated to exercise on their state and prospects. I cannot resist the conclusion, however, that the different views taken by our operatives and those of the United States upon this subject are determined by other and powerful causes, besides those dependent on the supply of labour in the two countries. The principles which ought to regulate the relations between the employer and the employed seem to be thoroughly understood and appreciated in the United States, and while the law of limited liability affords the most ample facilities for the investment of capital in business, the intelligent and educated artizan is left equally free to earn all that he can, by making the best use of his hands, without let or hindrance by his fellows.

It may be that the working classes exhibit an unusual independence of manner, but the same feeling insures the due performance of what they consider to be their duty with less supervision than is required where dependence is to be placed upon uneducated hands.

It rarely happens that a workman who possesses peculiar skill in his craft is disqualified to take the responsible position of superintendent, by the want of education and general knowledge, as is frequently the case in this country. In every State in the Union, and particularly in the north, education is, by means of the common schools, placed within the reach of each individual, and all classes avail themselves of the opportunities afforded. The desire of knowledge so early implanted is greatly increased, while the facilities for diffusing it are amply provided through the instrumentality of an almost universal press. No taxation of any kind has been suffered to interfere with the free development of this powerful agent for promoting the intelligence of the people, and the consequence is, that where the humblest labourer can indulge in the luxury of his daily paper, everybody reads, and thought and intelligence penetrate through the lowest grades of society. The benefits which thus result from a liberal system of education and a cheap press to the working classes of the United States can hardly be over-estimated in a national point of view; but it is to the co-operation of both that they must undoubtedly be ascribed. For if, selecting a proof from among the European States, the condition of Prussia be considered, it will be found that the people of that country, as a body, have not made that progress which, from the great attention paid to the education of all classes, might have been anticipated; and this must certainly be ascribed to the restrictions laid upon the press, which have so materially impeded the general advancement of the people. Wherever education and an unrestricted press are allowed full scope to exercise their united influence, progress and improvement are the certain results, and among the many benefits which arise from their joint co-operation may be ranked most prominently the value which they teach men to place upon intelligent contrivance; the readiness with which they cause new improvements to be received, and the impulse which they thus unavoidably give to that inventive spirit which is gradually emancipating man from the rude forms of labour, and making what were regarded as the luxuries of one age to be looked upon in the next as the ordinary and necessary conditions of human existence.

(Signed) JOSEPH WHITWORTH.

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